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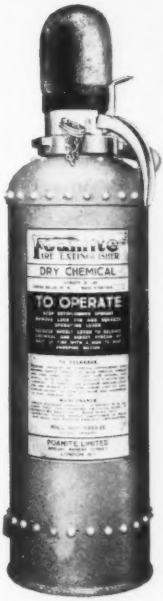

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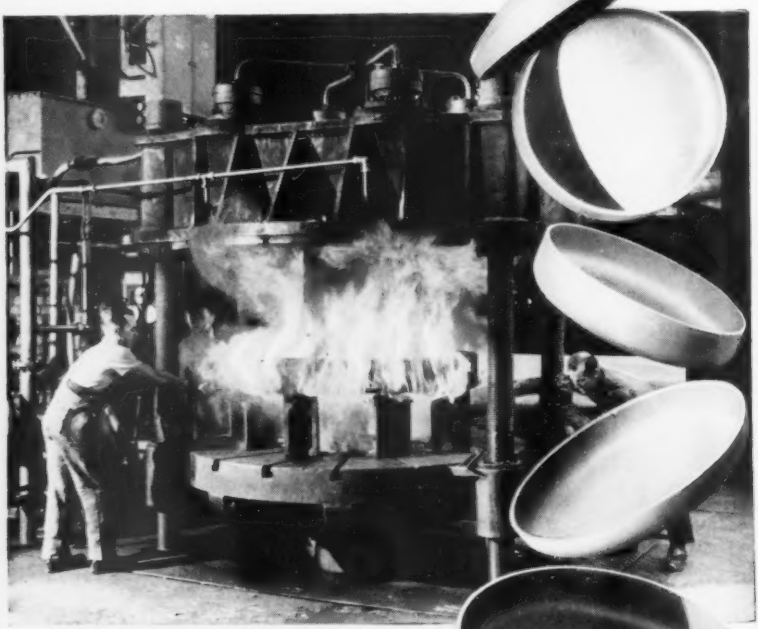

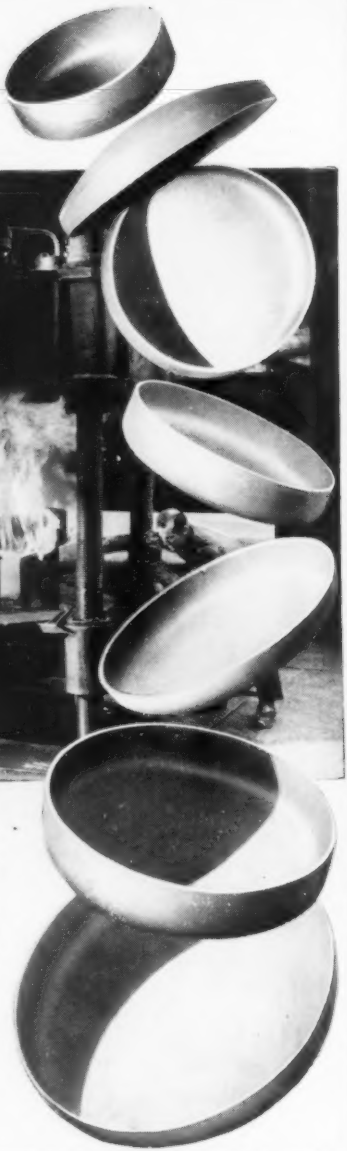

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THE OILFIELDS OF IRAQ

NEW FIELD AT ZUBAIR INAUGURATED

On January 10, 1952, the new oilfield at Zubair in southern Iraq was formally inaugurated by His Excellency Nuri Pasha-el-Said, Prime Minister of Iraq. The central degassing station at Zubair was the scene of the ceremony and, in the presence of a large gathering, the Prime Minister opened a valve which set in motion one of the pumps used to transfer the crude oil to Fao for shipment.

The Prime Minister was accompanied by Mr H. S. Gibson, C.B.E., F.Inst.Pet., managing director of the Iraq Petroleum Co., of the Basrah Petroleum Co., and of associated companies. Among those present at the opening ceremony and at the luncheon which followed were: Sir John Troutbeck (*British Ambassador*), Mr E. S. Crocker (*U.S.A. Ambassador*), Jamil al Madfai (*President of the Senate*), Abdul Wahhab Marjam (*President of the Chamber of Deputies*), Dr Dhia Ja'afar (*Minister of Communications and Works*), Khalil Kanna (*Minister of Education*), Abdul Majid Bey Mahmoud (*Minister of Economics*), Ahmed Pasha Al-Rawi (*Minister Plenipotentiary*), Abdul Melik Khederi (*Minister Plenipotentiary*), Ahmed Muktar Baban (*Rais of the Royal Diwan*), Brig. Abbass 'Ali Ghalib, Air Vice-Marshal Beamish, B. A. Piets (*Chargé d'Affaires of the Netherlands*), Dr Nadim al Pachachi (*Director-General of Economics*), Mohamed Beg Naqib (*Director-General of Oil Affairs*), Sayid Ibraham Khalil (*Director-General of Propaganda*), Sayid Ehsan Fifa'at (*Director of Mines*), together with several members of the Senate and of the Chamber of Deputies, and many officials from the oilfields and

oil installations in Iraq and neighbouring countries.

From London a special party had been flown to Basrah for the opening ceremony and in addition to Mr and Mrs Gibson, included the following from the I.P.C. head office: Sir Herbert and Lady Todd, Brig. and Mrs. S. H. Longrigg, Mr and Mrs D. Glynn-Jones, Mr and Mrs E. E. Upton, N. E. Baker, J. B. Edwardes, L. V. A. Fowle, O. H. Griffiths, R. Hayes, G. H. Herridge, and E. A. Kinch, together with The Hon. M. R. and Mrs Bridgeman (*Anglo-Iranian Oil Co.*), Mr and Mrs F. O. Canfield (*Standard Oil Co.* (*New Jersey*)), C. F. Darlington (*Socony-Vacuum Oil Co.*), Mr and Mrs H. E. W. Kirby (*Anglo-Saxon Petroleum Co.*), and H. I. Lloyd (*Barrister-at-Law*). The following press representatives were also included in the London party: Mrs E. J. Dichter (*Petroleum Times*), J. Midgley (*The Times*), George Sell (*Institute of Petroleum*), Kenneth Williams (*Al Ahram*), and Douglas Willis (*B.B.C.*).

Following the official ceremony, the guests toured the Zubair oilfield, visiting various drilling and producing wells, including the discovery well. In the Industrial Area Mr Sami Nasr, divisional geologist on the field, gave a descriptive talk in Arabic and in English on the general geology of the Zubair field. The party then proceeded to the Makinah depot, Basrah, where, in a building tastefully decorated with bunting in the national colours and with oriental carpets, an excellent lunch was served.

Luncheon Speeches

Following the lunch, Mr H. S. Gibson, C.B.E., F.Inst.Pet., managing director of the Basrah Petroleum Co., said:

The ceremony which Your Excellency has so graciously consented to perform marks the culmination of six years of

His Excellency Nuri Pasha-el-Said (centre) *and Mr H. S. Gibson approaching Zubair degassing station*

intensive effort. To-day, oil flows through a pipeline to Fao from an oil reservoir two miles below the surface of the ground at Zubair, which is thus one of the deepest producing oilfields in the world.

Geophysical Exploration

This oilfield at Zubair owes its discovery to the modern science of geophysics. At Zubair, there is neither seepage nor surface evidence of geological structure, so the geophysicists were called in, and the credit for the discovery goes to them.

The concession covering this part of Iraq was granted to the Basrah Petroleum Company at the end of November 1938, and geological exploration commenced immediately, extensive work being done in the Amara area before the outbreak of the second world war. During the war, it was not possible to undertake active exploration, but the Company's geologists continued their careful and patient study of all the available evidence both from Iraq and from the neighbouring countries, and they concluded that conditions for the formation and accumulation of oil might be more favourable in the unknown territory beneath the plains and marshes of the Basrah region than those regions to the north where the surface geology could be studied.

The Hon. M. R. Bridgeman, "Paddy" Hayes, and O. H. Griffiths at Rome airport

The Prime Minister speaking before performing the opening ceremony

Even before the end of the war, the Company ordered deep drilling equipment, and having decided that geophysical surveys were necessary, arranged that they should be carried out in the vicinity of Basrah immediately the war finished. These arrangements enabled gravity, magnetic and seismic surveys of the Basrah area to begin in 1945. The results suggested the possibility of the existence of a number of potentially oil-bearing structures, and test wells were located on the most promising of these at Zubair, Nahr Umr, and Ratawi.

Deep Drilling Needed

As a result of its enterprise in sponsoring the manufacture of deep drilling equipment in the United Kingdom, the Basrah Petroleum Company and its associates obtained the first outfits to be

built after the war, and two of these commenced drilling in February and March 1948, one at Zubair and the other at Nahr Umr. Both wells penetrated oil-bearing sands between the depths of 10,000 and 11,000 feet at Zubair and between 8000 and 9000 feet at Nahr Umr and, in September 1948, the Company was able to inform the Government that oil in commercial quantities had been found.

Further wells were drilled at both places, but the second one at Nahr Umr encountered water, and in consequence drilling effort was concentrated at Zubair with the object of commencing the export of oil at the earliest possible moment. Six drilling outfits have been employed. Twelve wells have already been completed and five more are in progress. These wells are approximately four times as deep as the producing wells at Kirkuk and more than twice as deep as those in Kuwait, and a total of over 200,000 feet has been drilled to date.

But much more was necessary before oil could be exported: field installations, storage tanks, a power station and workshops have been constructed at Zubair; stores, offices, commissariat, and transport depots at Makinah; a 70-mile pipeline to Fao; and at Fao, storage tanks, pumphouse, and loading jetties. The expenditure incurred before the first tanker left its jetty was over £18 million. The provision of all these services has necessitated the importation of nearly 100,000 tons of materials and equipment, and the employment of 2500 men directly by the Company, in addition to those employed by contractors.

A producing well in the Zubair oilfield—over two miles deep

Opening Date Anticipated

As a result of their efforts, Your Excellency, we were able not only to anticipate by nine months our contractual obligation to export oil by September 1952, but we were also able to commence exports on December 19, three weeks earlier than was expected when the date of this ceremony was fixed. We are grateful for the efforts of our personnel of all grades and for the co-operation of local Government officials which has made this possible. This, however, is only a stage in the development of the Basrah Petroleum Company. It is our intention to continue our efforts so that by the end of 1955 the rate of production will be 8 million tons per annum.

It is the very definite policy of my company to maintain a uniform level of employment in its operations, because by so doing it can make a major contribution towards the prosperity of the people of Basrah, and form a valuable element of stability in the economy of the country.

A uniform level of employment also goes hand-in-hand with efficiency of operations, which under the new agreement reached with Your Excellency and now awaiting ratification by Parliament, is a matter of interest to Your Excellency's Government, since the basis of the agreement is an equal sharing of the

profits arising from the Company's operations in Iraq. In this connexion, I am happy to announce that the Iraq Petroleum Company has been able to accelerate the construction of its 30-inch pipeline from Kirkuk to Banias by approximately six months. It is expected that the section from K.3 to Banias will be completed within the next few weeks, and that it will thus be possible to begin exporting oil through the 30-inch line during April, with the result that the delivery of crude to the Mediterranean coast during 1952 will be between 3 and 4 million tons greater than had been anticipated.

Through the arrangements made by Your Excellency's Government for the utilization of the revenues from the oil companies for the projects of the Development Board, they will contribute to improved standards of life throughout Iraq. To all our personnel, Iraqi or foreign, it is an incentive, and a source of deep satisfaction, that the fruits of their labours will so benefit the peoples of this historic land.

It is our privilege to participate in the development of a land which was the cradle of civilization and which, until the seventh century of the Hijra, was one of the granaries of the world. As a result of barbarian vandalism its irrigation dykes and headworks were destroyed, and this most fertile part of the fertile crescent became desert. But soon, irrigation works at Waddi Tharthar and Habbaniyah will once more bring life giving water to the land. The rich earth will once more bring forth its bounty, and it is our prayer that peace as well as plenty may prevail.

The Prime Minister's Speech

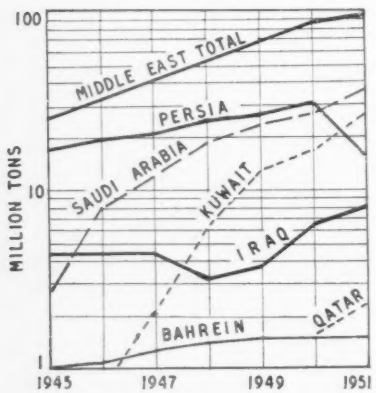
His Excellency Nuri Pasha-el-Said said:

I do not deny the efforts of the Company in the critical circumstances referred to and I appreciate all that has been done to arrive at this result; but at the same time we ask for more.

The national Government came to power at a time when the country was sunk in poverty, ignorance, and disease, without schools or hospitals. We have done our best to improve conditions to the extent of our limited resources and we have thus been able to overcome many difficulties; but we have still a long way to go. The world is making great strides forward and we are determined to keep pace with this progress and not lag behind the progressive nations, whatever effort and sacrifices this might cost us.

Only a few miles away stands the almost silent refinery at Abadan. A flare in the distillation area (left) a little smoke from one stack of the power house, and a completely bare waterfront, showed how little use was being made of the world's largest refinery

Gentlemen, about fourteen years ago the Government granted to the Basrah Petroleum Company the concession for exploiting oil in this area and the people of Iraq have displayed uneasiness at the procrastination of the Company in extracting oil, not taking into consideration the causes and factors that led to this state of affairs, but to-day, as we see oil flowing from its springs, we have definite hope that the Company will open a new page in its activities in Iraq, thus enabling it to change the feelings of the Iraqis towards it. This will not be accomplished unless the Company does its best to increase the quantities of oil produced and exported on no less a scale, if not greater, than that on which it is extracted by the companies in one of the neighbouring States. The Company has, moreover, an absolute duty to take care of its employees and workmen and promote their welfare in social affairs and those relating to culture and hygiene and open the way to them to display their capacities and talents, each in his own field.



In recent years Middle East oil production has steadily increased at a uniform percentage rate. The lowering of this rate in 1951 by the defection of Persia will be more than made up in 1952

All Iraqis expect oil to be an important source of income that will enable them to build up their country and raise their standard of living by educating their children so that they can participate effectively in building civilization and culture and play the part played by their ancestors. When the Company keeps this fact constantly in view, it can create an atmosphere of friendliness and co-operation; and this is what we expect from the Basrah Petroleum Company. We are determined to carry through our programme of reform in the various spheres of life, so as to stamp out the plagues we have inherited.

At the conclusion of the speeches, leading Iraqi officials were presented with special souvenirs of the inauguration and each guest was given a silver ashtray, on which was mounted the crest of the Basrah Petroleum Company.

Simultaneously with the lunch to the Prime Minister and the official guests, all Iraqi personnel were entertained to luncheon and all received a memento of the occasion.

In the evening after the opening ceremony, Mr L. J. F. Teyssot, general manager of the Basrah Petroleum Company was host at a reception at the Shatt-al-Arab Hotel. A large number of guests, including the Prime Minister and Mr and Mrs H. S. Gibson, were in attendance. Dancing, with an interval for a cabaret, continued until the early hours.

Visit to Fao

On the day after the inauguration at Zubair, the guests were taken by road to Fao, a journey of some 50 miles across the desert. Here, the 16,000-ton tanker *President Meny* was lying at the jetty after loading a cargo of Zubair crude. After inspecting the ship and the facilities at the terminal, the party proceeded to the Fao Port Club for an excellent buffet lunch.

THE ZUBAIR OILFIELD

In November 1938 a 75-year concession was granted to the Basrah Petroleum Company, an associated company of the Iraq Petroleum Company, and covered southern Iraq south of latitude 33.

Prior to the war extensive work was carried out in the Amara area but, for reasons beyond the control of the company, no further work was possible until the war ceased. Then an intensive geophysical survey—gravimetric, magnetic, and seismic—was undertaken in the southern portion of the area and indicated potential oil-bearing structures. As a result test wells were located at Zubair, Nahr Umr, and Ratawi, that at Zubair being near the crest maximum of a gentle anticline tending NNW-SSE some twenty miles south-west of Basrah. Drilling began in February 1948 and by March 1949 oil in commercial quantities had been proved in Cretaceous sandstones between 10,000 and 11,000 feet in depth. A second well ten miles to the south was also successful, but the full extent of the Zubair field has yet to be determined.

The general geological section revealed by drilling is:

Age	Local Name	Description	Thickness ft
Miocene	Dibdibba	Sands, gravels,	900
	Lower Fars	Gypsum, marls, limestone	600
	Abu Ghar	Sands, gravels	500
Eocene	Bahrein	Limestone, locally dolomitic	700
	Rus	Anhydrite with limestone	400
	Aidah	Marly limestone	1500
Upper Cretaceous	Aruma	Marly and chalky limestones with marls with shales	2600
Middle Cretaceous	Khatiyah	Marls, limestone	1600
	Mauddud	Limestone	500
	Nahr Umr	Sandstone, shale	1000
Lower Cretaceous	Shu'aiba	Limestone	200
	Zubair	Sandstone, shale	600

Drilling Programme

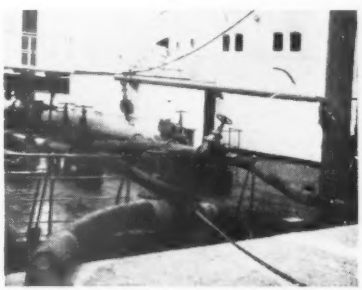
After qualitative and quantitative tests had proved satisfactory it was decided to develop the area around the discovery well for an initial production of 2½ million tons per annum by the end of 1952 from fifteen wells. Twelve wells have already been drilled, five are in course of drilling, and three sites are being prepared. Wells are drilled on a 1¼-mile grid basis and it is planned to gradually increase production to 8 million tons per annum by the end of 1955 subject to the new agreement recently ratified by the Iraq Government.

Drilling time for a depth of 10,000 to 11,000 feet averages 150 days and a typical casing programme is:

16 inch to 800-900 ft
11¾ ,, ,, 2750 ft
8⅝ ,, ,, 8000 ft
5½ ,, ,, final depth

Production Scheme

From the producing wells the crude



The President Meny taking on a cargo of Zubair crude at Fao

oil flows through high-pressure flow lines to a central degassing station. Here the gas is released in five stages through horizontal separators, the final stage being to flow tanks. From the flow tanks the stabilized crude is transferred by a small centrifugal pump to three large storage tanks for pumping to Fao. For the last stage there are four gas-driven and two diesel-driven pumps, surplus gas being used as fuel in the gas-driven pumps.

A power station with three 100 kVA generators is part of the degassing station.

The 75-mile pipeline from the degassing station to Fao terminal is 12 inches in diameter, except for the last 10 miles which is of 16-inch diameter. The line is laid on 8-ft concrete sleepers, expansion and contraction being provided for by movement in a vertical plane.

It is understood that at a later date a 24-inch line will be provided to permit the handling of increased production.

Fao Terminal

Storage capacity at the Fao terminal on the banks of the Shatt-al-Arab river consists of eight 164 ft × 40 ft floating-roof tanks, each capable of holding 19,000 tons (4.75 million gallons) of crude oil.

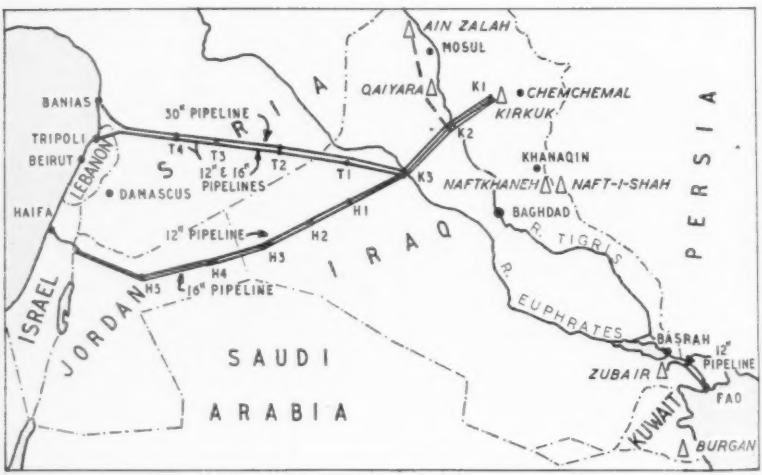
At present one jetty has been completed and two others are in course of construction, each being capable of berthing a 16,000-ton tanker. This is the largest size vessel which can proceed up the river on account of the sand bar at the mouth.

Each jetty will be provided with four loading lines connected by a header to the 24-inch mains from the storage farm, electric-driven loading pumps giving a loading rate of 2000 tons per hour.

Equipment for night-loading is provided and steam and fresh water are available for tankers, the latter being obtained from Seeba, through a 30-mile 4-inch pipeline and filtration plant.

The power station has three 650 kVA generators, and the terminal has its own industrial area, hospital, etc.

The first tanker was loaded on December 19, 1951, anticipating the target date by nine months and the inaugural ceremony by three weeks.



Materials and Personnel

To bring this enterprise into being has involved the import of over 90,000 tons of material and equipment, including six deep drilling rigs, tankage, line pipe, generators, and the host of things which go to make an oilfield.

Much of the work of erecting plant, tanks, buildings, etc., and the fabrication of fittings has been performed by Iraqi contractors, and in addition the Basrah Petroleum Company's own personnel numbered some 2500 Iraqis. It is the policy of the Company to employ local labour wherever possible and Iraqis are engaged and being trained to take senior positions in the organization.

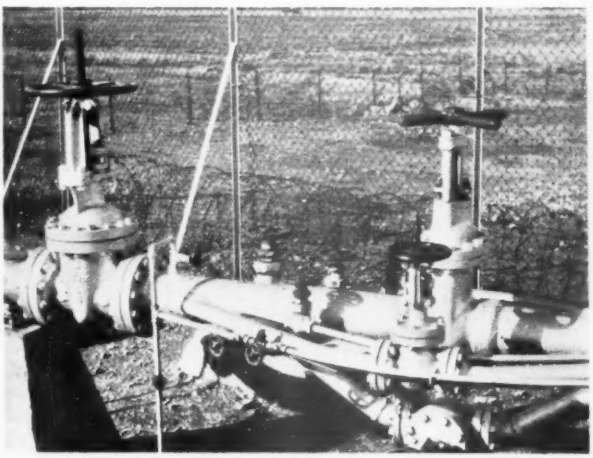
THE KIRKUK OILFIELD

After the inauguration ceremonies at Zubair were concluded, the press representatives were, through the courtesy of the IPC, given the opportunity of visiting the main oilfield at Kirkuk, the Kirkuk-Mediterranean pipeline, and other installations. These will be described in broad and general terms.

The Kirkuk oilfield is situated at a distance of 160 miles due north of Baghdad and consists in effect of three connected elongated domes lying in an area of about 65 by 1 to 1½ miles. General trend of the field is north-west.

It is of interest to note that Baba—or to give it its full name Baba Gurgur—is the location of a gas seepage which has burned continuously (except for a period during the war when it was extinguished as an air-raid precaution) since the days of King Nebuchadnezzar. In fact those "eternal fires" are reputed to be those into which Shadrach, Meshach, and Abed-nego were cast (Daniel III). By day the fires are not particularly impressive but by night the bright blue flame presents a sight to be remembered.

In the centre, or Avanah dome, production is expected to commence during



Kirkuk wells are controlled by means of a series of by-passes to give any desired flow rate

A circle of blackened stones show the position of the "eternal fires" at Baba Gurgur. At night the dancing flames are an attractive sight

1952 and two degassing stations with a daily capacity of 100,000 barrels are being erected at Sarbashakh and Sarabu. These will be connected to the main stabilization plant by a pipeline which will cross the Lesser Zab via a new reinforced concrete bridge now under construction. This bridge will also carry road and water pipes from the pumping station on the river bank nearby.

Present production is from 16 wells in the southern (Baba) dome, the average depth to the producing zone being about 2500 feet. The flow line from each well goes direct to a central degassing station, the lines being graded and laid to minimize the possible formation of gas pockets. In this southern area there are four similar degassing stations—at Shurau, Baba, Hanjira and Qutan from south to north, the capacities of which are at the moment being increased to 150,000 barrels per day each to allow for expanded production.

As the oil is produced from the wells, it contains about 200 cu.ft. of dissolved gas per barrel. At each degassing station the crude flows through vertical gas separators in which the gas content is reduced to about 50 cu.ft. These separators, about 35 ft in height and 7 ft in diameter, are of special design. The crude oil enters the column tangentially at a point about half-way up, and flows down a spiral tray which provides the maximum surface area. The released gas passes upwards and is led to the flares, the partly-degassed crude being taken off at the bottom and conveyed by pipeline to the stabilization plant.

Flow from the wells is controlled so that the separators at the degassing stations operate at a pressure of 50-60 p.s.i. At wells the production string is carried to the control valve on the 6-inch flow line in a smooth bend, and at selected wells the valve is provided with a series of by-pass lines of diameters varying from $\frac{3}{4}$ to $2\frac{1}{2}$ inches.

Part of the stabilization plant at Kirkuk with K.I pumps station in the background

Stabilization Plant

At the stabilization plant, the crude oil is received into three 5000-brl Hortonspheres which act as secondary separators and which can supply gas for use as fuel in the plant.

Crude from the Hortonspheres is pumped via heat exchangers to the primary column of the stabilizer. From this the bottoms are recirculated through tube stills to maintain the base temperature at about 450°F and overheads are charged to the secondary column for fractionation and recovery of butane, with waste gases being vented and burned. The bottoms from both columns are blended to give a stabilized product of about 4 p.s.i. Reid vapour pressure which then flows by gravity to the first pump station (K.1) on the main pipeline. During the stabilization process the hydrogen-sulphide content of the crude is reduced from about 0.32 to less than 0.001 per cent. There are at present eight stabilization units and a ninth is in course of erection.

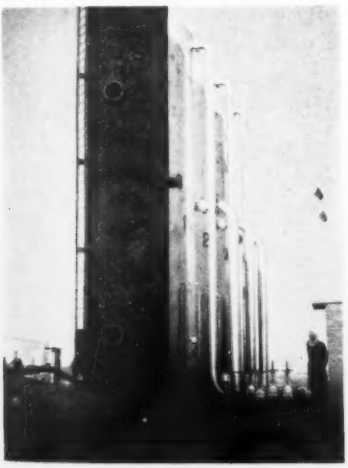
There are also two small topping plants at the stabilization plant. These have a total capacity of 2500 barrels per day and produce motor spirit, kerosine, and diesel oil for the company's own use and for local markets, the residue being returned to the crude flow lines. A small ethyl blending plant is provided so that the octane number of the motor spirit can be increased by the addition of tetra-ethyl lead.

OTHER IRAQ FIELDS

Apart from the oilfields already described, there are several other areas in Iraq where oil has been found in varying quantities.

The principal area outside Kirkuk and Basrah is at Ain Zalah, some 40 miles north-west of Mosul, where oil was first found in 1940 at depths of 5000 to 6000 ft. This field, which is estimated to be capable of producing about 1 million tons per annum, is expected to be in active production before the end of 1952 and a 12-inch pipeline is to be laid to join the main Kirkuk-Banias pipeline at station K.2.

Although considerable reserves of oil have been proved in the Qaiyarah



Baba Gurgur degassing station with an additional separator in course of erection

Product tanks at the stabilization plant nestle together on the hillside

structure, about 40 miles south of Mosul, the oil has such a high asphalt content as to make its refinement uneconomic.

At Chemchemal, about 30 miles to the east of Kirkuk, exploratory drilling is about to commence, and at Khor-Mor south-east of Kirkuk a seismic survey is to be undertaken.

THE IRAQ PIPELINES

The most interesting part of the journey by air and road down the pipelines running from Kirkuk to the Mediterranean was the drive from station K.3 at Haditha to station T.1, for it was on this portion of the route that the new 30-inch line was in course of construction. It was thus possible to witness every stage of pipeline building in actual progress — stringing, ditching, pipe cleaning, bending, alignment, welding, weld examination, wrapping, testing of wrapping, lowering, and finally backfilling of the trench.

At present the operating pipelines are two 16-inch and two 12-inch lines from Kirkuk to Station K.3 on the west bank of the R. Euphrates, and one 16-inch and one 12-inch line from here to Tripoli in the Lebanon. There are also a 16-inch and a 12-inch line from K.3 to Haifa in Israel, but since the dispute between the Arab States and Palestine, this line has not been in use.

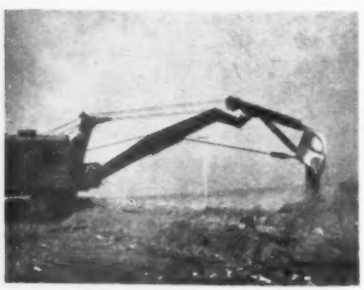
It was in order to deal with the expanding production from the rich Kirkuk field that the construction of the new 30-inch line from Kirkuk to Banias was planned some time before the Israel-Arab war started.

Progress on the new 30-inch line is at present six months ahead of schedule and it is anticipated that the first export of crude oil from the new port at Banias will be made in April. The line, which will be 556 miles in length, will have diameters varying from 32 to 26 inch. On the delivery side of the pumps there will be a section of 30-inch pipe going up to 32-inch as the line nears the next station, with a 26-inch section from the Homs gap to Banias. Although for the 16- and 12-inch lines seven pumping stations are provided between Kirkuk and Tripoli, only four will be needed for the 30-inch line—K.1, K.3, T.2, and T.4.

All the 160,000 tons of steel for the 30-inch pipeline came from America and required 34 ships for its transport. In addition, some 50 million ton-miles of rail and motor transport were needed to distribute the material from the ports of Tripoli and Basrah.

Equipment and materials for the

—30-inch pipe picked up like a match



Pipeline under construction—trench digging made easy

pumping stations along the route have come from the U.K.

Present capacity of the 16- and 12-inch lines to Tripoli is 130,000 barrels per day. By the end of the year it is expected that this capacity will have been increased to 430,000 barrels and, when the 30-inch line is fully in operation, the maximum aggregate flow from Kirkuk to the Mediterranean coast at Banias and Tripoli will be 470,000 barrels per day, or 22.5 million tons per year.

—the wrapping machine has to be seen to be believed

—all along the section under construction operations follow in correct sequence

Banias Port

At the new port of Banias, construction work was in active progress at the time of the visit. Eight of the 164 × 56 ft tanks, each with a working capacity (90 per cent full) of 180,000 barrels, were completed or approaching completion and 16 more are to be erected before the tank farm is finished.

From these tanks, the base elevations of which are 57 to 108 ft above sea level, the out-take lines will run to a manifold. From the manifold, six loading lines will run to six deep-sea loading berths. The three lines nearest to the tank farm will be of 32-inch diameter and, in order to maintain loading pressures, the other three will have diameters of 24 inches.

A harbour is being built to provide unloading and loading facilities and protection for cargo vessels, and staff quarters and the necessary accommodation is rapidly taking shape.

—and so to bed. A padding of soft earth will be put round the pipe before the trench is filled

REFINING IN IRAQ

The main source of petroleum products for retail distribution in Iraq at present is the Alwand refinery of the Khanaqin Oil Company, a subsidiary of Anglo-Iranian Oil Co. Crude oil for the refinery, which has a capacity of about 7000 barrels per day, is obtained from the Naftkhaneh oilfield on the Iraq-Persian frontier some 80 miles north-east of Baghdad, this field being a continuation of the Naft-i-Shah field across the border.

Some supplies were also obtained from Abadan but consequent upon the policy of the Persian Government these have ceased and also the output of the Alwand refinery has found some difficulty in maintaining supplies. Retail distribution in Iraq is carried out by the Rafidain Oil Co., until recently a subsidiary of the Anglo-Iranian, with depots in all principal centres. Thus, at Basrah there is a large depot with rail and river facilities and this depot is the supply centre for a large area of southern Iraq. In order to counteract the loss of previous supplies a topping plant with a capacity of about 120,000 tons per year is now under construction on a site adjoining the Basrah depot. A 6-inch pipeline is being laid from the Zubair field and it is proposed to top Zubair crude to produce gasoline, kerosine, and fuel oil for local markets and railways. It is anticipated that the plant will be in operation by mid-1952.

Site clearing for the Rafidain Oil Co's new refinery at Basrah

Incidentally, the Rafidain Oil Company has recently been nationalized by the Iraq Government.

Under the terms of the new agreement between the Iraq Petroleum Company and the Iraq Government, the Government is entitled to take part of its royalty in kind. It is, therefore, the plan of the Government to erect a refinery at a site about 5 miles south of Baghdad. Building contracts have been placed and the capacity will be about one million tons per year to supply internal needs.

Personnel and Training

Throughout the visit, it was particularly noticeable that considerable numbers of Iraqi nationals are engaged in the operations of the Iraq Petroleum Company, many of them in responsible and senior positions. It is the policy of the Company to encourage Iraqis to train for such posts.

At Kirkuk a training centre commenced operation in 1948, taking in some 20 entrants each half-year, the pupils being of 15 to 16 years of age. After six months basic training in languages, mathematics, and elementary science, with tuition in carpentry, engineering, fitting, welding, etc., the pupils are then put to work under supervision in various departments.

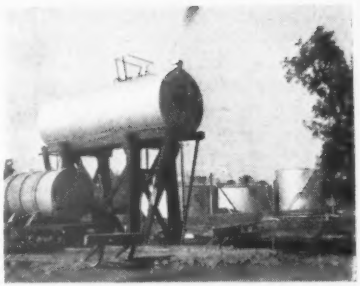
Selected pupils are given a 4-year intermediate course at the end of which the most promising are picked out to be sent to the United Kingdom for training at universities, technical colleges, and in large engineering establishments.

At present some 70 Iraqi students are in the U.K. under a scheme worked out in agreement with the Iraq Government.

It is intended to send 50 each year and eventually to maintain a total of 250 under higher training in Britain.

As in most parts of the world there is a housing shortage in Iraq, but, as far as the Iraq Petroleum Company is concerned, there is no lack of effort to provide accommodation for the Iraqi employees. Literally hundreds of houses of all types have been and are being built. It might also be mentioned here that the Company provides electricity at cost for the town of Kirkuk as well as furnishing a considerable supply of water to the town.

And, not least of all, reference must be made to the magnificent and well-equipped hospital at Kirkuk, now being further extended to provide additional facilities for the oilfield staff and their dependants.



Basrah depot of the Rafidain Oil Co.

ACKNOWLEDGMENTS

The editor wishes to acknowledge his indebtedness to those who made possible the foregoing account of the Iraq oil industry; to those who gave so willingly and freely of their time to discuss and explain technical details; to those who took great care to direct attention and to arrange visits to those places of historical and architectural interest which could have been easily missed in a technical visit. There are many people and numerous happy incidents to be remembered for many years. To all—grateful thanks.

THE NEW AGREEMENT

The new Agreement recently signed between the Government of Iraq and the Group of Companies represented by the Iraq Petroleum Company, comprising British, Dutch, French and American interests, was approved by the Iraq Chamber of Deputies on 14 February 1952, and was ratified by the Senate on 17 February. This concludes a series of friendly negotiations which began in 1950. In August 1951 the Prime Minister of Iraq announced that agreement had been reached in principle to the equal sharing between the Government and the oil companies of the profits accruing from the production and export of crude oil from Iraq. Then followed a process of drafting an agreement embodying all the details and the signing of the final document on 3 February 1952 by His Excellency, Abdul Majid Mahmoud, Minister of Economics on behalf of the Iraq Government, and Mr H. S. Gibson, C.B.E., managing director of the Iraq, Mosul, and Basrah Petroleum Companies. The terms of the Agreement are retroactive from 1 January 1951.

The profits from the companies' operations will vary on the basis of prices and costs ruling from time to time. On the basis of current estimates, the Iraq share of the profits provides for the Iraq Government an expectation of revenues from this source of £31 million in 1952, rising each year to nearly £60 million in 1955.

The Government has announced its

decision to set aside 70 per cent of these revenues for the projects of the Iraq Development Board, including flood control and irrigation schemes, schools, hospitals, and other amenities.

The companies have guaranteed to produce certain minimum quantities of crude oil. The Iraq Petroleum Company and the Mosul Petroleum Company will together produce a minimum of 22 million tons of crude oil a year from 1954 onwards, and the Basrah Petroleum Company has undertaken to produce annually a minimum of 8 million tons from the end of 1955.

The Iraq Government is assured in all circumstances that its total income will not be less than 25 per cent of the seaboard value of all crude oil exported by the Iraq Petroleum Company and Mosul Petroleum Company plus 33⅓ per cent of the seaboard value of crude exported by Basrah Petroleum Company. Fluctuation of world prices is to be taken into account in ascertaining the profits to be shared between the Iraq Government and the oil companies. The Iraq Government, as part of its 50 per cent share of profits, will be entitled to take in kind at seaboard 12½ per cent of the oil produced for export by the three companies. The Iraq Government can either dispose of this oil in the open market or sell it back to the companies at prevailing world market prices. A large part of the balance of the Government's revenue will be received in the form of income tax.

Subject only to circumstances beyond the control of the companies the Iraq Government is guaranteed that its share of profits shall not be less than £20 million (sterling) in 1953 and in 1954 and not less than £25 million in 1955 and each year thereafter.

The Government's interests are further safeguarded by the provision that, in the event of production of oil from Iraq being precluded by circumstances beyond the control of the companies, they will pay the Iraq Government a minimum of £5 million annually for a period up to two years.

Provision has been made to increase the opportunities of Iraqi nationals to participate in the development of their country's oil resources and the number of Iraqi directors on the boards of the companies will be increased.

KUWAIT

During the stay in Basrah, it was made possible for the party to visit the neighbouring independent State of Kuwait and to obtain a quick impression of one of the richest individual oilfields of the world.

After landing at the airport, and before taking the road to the Kuwait Oil Company's headquarters at Ahmadi, the party drove through the ancient walled city of Kuwait. The road from the town of Kuwait to Ahmadi traverses the desert for about 22 miles—22 miles of sandy waste relieved only by telegraph poles and a water pipeline, and some 12 miles from the town, by the buildings at Magwa, which is the site of the first oil camp, and where the Company now has its hospital and training centre.

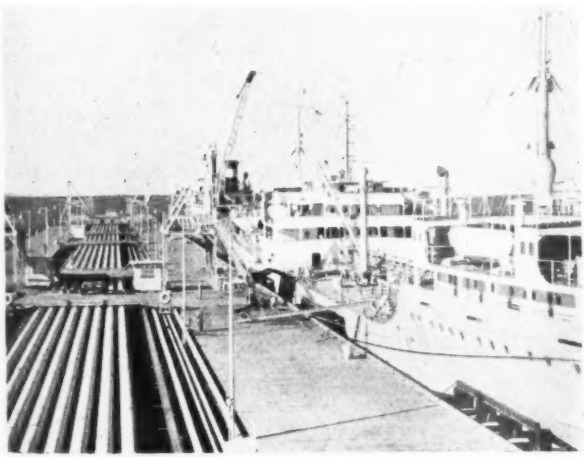
It is in the Magwa area that the new test well, about ten miles from the main Burgan field, was brought-in early in 1952. At the time of the visit, this well was undergoing production tests to determine whether it was obtaining its oil from an extension of the Burgan field, or whether a new oil-producing horizon had been located.

The seawara end of the world's largest oil-loading jetty

Ahmadi

At Ahmadi it was striking to note how much construction had been done in the comparatively short space of five years since work was first started. Offices, stores, air-conditioned dwelling houses, club house, guest houses, and the necessary roads and other facilities are all arranged in orderly fashion on the sloping ground going down to the shore, and garden cultivation was a welcome contrast to the scrub of the desert. More building is in progress to meet the housing needs of the Company's employees, a large proportion of whom are Kuwaiti Arabs.

At the top of the slope stands the tank farm with its twenty-one floating

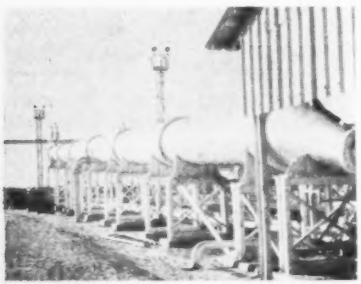


—with eight 24-inch loading lines and berths for six tankers

roof tanks varying in capacity from 139,000 to 168,000 barrels. From the tank farm, three 24-inch, and two 22-inch lines run down to the jetty.

The Jetty

The jetty at Ahmadi is the largest oil jetty in the world and with a loading average of 775,000 barrels per day has a record of having loaded 1,240,000 barrels in one day. This ¾-mile long jetty at present has berths for six of the largest tankers afloat and two cargo berths, both of which have recently been adapted for oil loading also, making eight berths at which oil can be loaded. Work is shortly to be started to enlarge the loading facilities to give accommodation for more vessels. At present it is quite a common sight to see tankers anchored in the bay awaiting a vacant berth.



Part of a degassing station in the Burgan field

Oil feed from the tank farm is by gravity and loading is so fast that it is proposed to build a cinema on the jetty to provide recreation for crews who have only a short spell of free time during loading operations.

A refinery, having a capacity in excess of one million tons per year is sited near the jetty. It produces motor fuel and kerosine for local needs and diesel and furnace oil for ships' bunkers.

The Burgan Field

The Burgan field of Kuwait is upwards of 10 miles from Ahmadi, covering nearly 140 square miles, and the oil is produced from four main sand bodies in the Middle or Lower Cretaceous. Maximum depth to the lowest horizon nowhere exceeds 5000 feet.

Prior to 1942 nine wells were drilled in the Burgan area and operations were then suspended until June 1946. Since then over 100 wells have been drilled. For the last six months of 1946, total oil production was nearly 800,000 tons, but since then it has steadily and rapidly increased until in 1951, it reached a total of nearly 28 million tons. It is anticipated that for 1952, a total of 40 million tons will be reached.

A particular feature of the Kuwait oilfield is that, owing to the nature of the territory, the 136-feet derricks used for drilling can be skidded to a new site without need for dismantling, and in order to facilitate this skidding, the rigs have been specially unitized. The whole operation from rigging down at one well to rigging up at a new well can be done in less than 24 hours.

In general wells are completed as dual producers, those in the centre of the field producing from the third and fourth sands and those on the flanks from the first and second combined and third sands.

From the wells, the flow lines are connected to a gathering centre (gas separator station), with a total capacity of about 110,000 barrels of crude per day. The first stage of separation is set at 425 psig and this is reduced to 10 psig in five stages—200, 100, 40, 25 and 10 psig. The gas separated at the 200 psig stage is used in turbines to drive centrifugal pumps for transfer of crude to local storage and gas is also used in gas engines to drive pumps transferring the crude to the main storage at Ahmadi. Waste gas is burned off in flares.

The cargo end of the Ahmadi jetty has been adapted or oil loading with two lines

Education

As in other parts of the Middle East, particular attention is paid to the training of the local Arab employee in order to fit him for more responsible posts in the oil industry. A school has been set up at Magwa and some striking examples were seen of the excellent class of work which can be obtained. Classes are held in carpentry, welding, pipe fitting and plumbing, basic engineering, fitting and the use of gauges. Language, chemistry and elementary science are also taught and the notebooks which were produced for examination were fine specimens of neatness and painstaking effort.

ACKNOWLEDGMENT

The editor is indebted to the management and staff of the Kuwait Oil Co. for the facilities so generously given and for the information provided.

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EMPIRE MINING AND METALLURGICAL CONGRESS

The fifth Empire Mining and Metallurgical Congress will be held in Australia from April 12 to May 23, 1953, and subsequently in New Zealand.

Programme of the Congress has been planned in five parts: pre-sessional visit in Tasmania; the inaugural meeting and other official functions, together with technical sessions, in Melbourne; visit to Canberra; further technical sessions and visits in Sydney; and finally excursions to mining and metallurgical centres.

In addition to the two principal technical sessions, in Melbourne and Sydney, there may be further technical sessions held at mining centres during the visits of Congress members.

The main section of the technical proceedings will take the form of a series of volumes dealing in an analytical and comparative manner with Australian mineral deposits and practices. Volumes will be as follows; I Geology of Australian ore deposits; II Mining methods; III Milling methods; IV Extraction metallurgy (a) ferrous and (b) non-ferrous; V Miscellaneous and general; VI Coal: VII General handbook. Papers will be invited from overseas sources on selected specific topics.

The Congress is open to all interested in the subjects to be discussed and communications should be addressed to the Secretary, Fifth Empire Mining and Metallurgical Congress, Osborne House, 399, Little Collins Street, Melbourne, Victoria, Australia. Copies of a circular giving details of the programme may be obtained from the General Secretary of the Institute of Petroleum.

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Fluid Hydroforming. A condensed version, but with the addition of recent pilot plant data, of the Hill-McGrath paper read at the ACS meeting in September is available from the M. W. Kellogg Co., 225 Broadway, New York 7, N.Y., U.S.A.

COUNCIL COMMENTARY

The President presided over the largest gathering of Council for many a month on February 13. Before the business of the Meeting commenced, Council stood in silence as a mark of respect to His Late Majesty, King George VI.

The Annual General Meeting of the Institute will be held this year on April 24, at the Institution of Mechanical Engineers. Tea will follow and Mr Southwell will then give his Presidential Address on Kuwait.

The Public Relations Committee have discussed a scheme for a Summer Meeting in 1952 and have made some preliminary arrangements. It is suggested that the Meeting take place at Hastings over a weekend—June 27 to 29. Tentative bookings have been made for a gathering of about 100 people, but this may possibly be extended to cope with 150 people, if necessary. The scheme includes three talks of a more or less popular nature, interspersed with social events, including a cocktail party, a dinner-dance, and a golf competition.

A Council Committee has now been appointed to deal with ASTM/IP co-ordination matters, and the results of a meeting held on January 29 were reported to Council. This Committee is comparing IP methods with the corresponding ASTM procedures and initial inspection shows that eight such methods are identical, 45 are closely similar, and 21 show considerable differences; 46 IP methods have no ASTM equivalents.

A meeting was held in Paris in January to discuss the Metric Edition of the Joint ASTM/IP Oil Measurement Tables. There were some differences of opinion, but conversations at the meeting sufficed to clear up all outstanding difficulties and differences. The President and General Secretary of the Institute of Petroleum have had some discussions with the Association Française des Techniciens du Pétrole on the setting up of a standardizing body in France and were able to render some assistance to their French colleagues in this matter.

A large part of this Council meeting dealt with matters affecting the constitution of the Institute and these will be reported as soon as matters have reached a more definite stage.

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PETROLEUM FILMS

Total showings of films loaned free of charge from the Petroleum Films Bureau in 1951 reached a record of 44,095 in 1951, an increase of nearly 8000 over 1950. Of these no fewer than 12,973 showings were made by educational authorities as follows: secondary modern schools, 6444; grammar schools, 2112; technical schools and colleges, 1830; public schools, 600; local education committees and visual aid groups, 525; primary schools, 497; training colleges, 408; universities, 404; continuation schools, 153.

In addition 110 prints were purchased at cost price by local authorities and two PFB films—*Wealth of the World—Oil* and *Forward a Century*—have been shown at cinemas throughout Great Britain.

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COMPANY PRODUCTION—CRUDE OIL

	1952	
	Jan.	Feb.
	Brl	
Trinidad Petroleum Development Co., Ltd.	258,185	241,037
British Controlled Oilfields Ltd.		
Venezuela :		
Western Area	12,445	12,163
Central Area	16,716	16,498
Kern Oil Co., Ltd. :		
California	115,542	104,116
Trinidad	71,897	67,617
	Tons	
Kuwait Oil Co.	2,837,666	

THE ANNUAL DINNER

A new record for attendance at the Institute's annual dinner was established on February 27, when a total of 850 members and guests assembled at Grosvenor House for the 1952 Dinner, which was held under the chairmanship of the President, Mr C. A. P. Southwell, M.C.

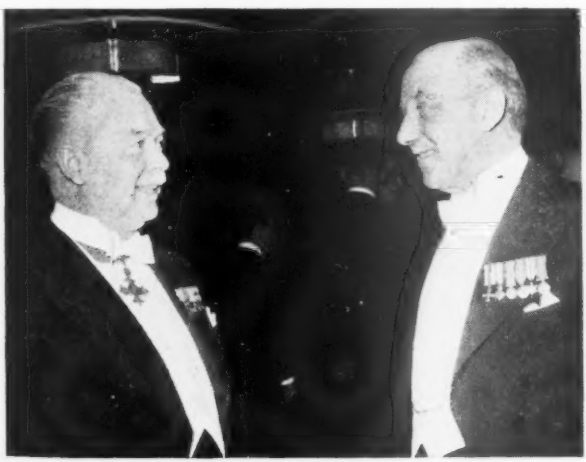
Immediately on assembly at the tables, and before dinner was served, the company observed a brief period of silence in tribute to the late King George VI—to use the President's words, "In memory of a great King and in sympathy with the Royal Family."

After Dinner the toast of "The Queen" was honoured.

Marshal of the Royal Air Force, The Lord Tedder, G.C.B., D.C.L., LL.D., was the guest of honour and his toast to "The Petroleum Industry" was replied to by Mr L. Sinclair (*chairman and managing director, Esso Petroleum Co. Ltd.*) The toast of "The Guests," proposed by the President, was responded to by Vice-Admiral (E) The Hon. Sir Denis Maxwell, K.C.B., C.B.E. (*Engineer-in-Chief of the Fleet*) and by Major-General John P. McConnell, U.S.A.F. (*Commanding General, 7th Air Division*).

The guest of honour—Marshal of the Royal Air Force, The Lord Tedder

The official guests included: Major-General W. E. V. Abraham, C.B.E., (*Burmah Oil Co. Ltd.*), R. J. Ayres, C.B.E. (*Ministry of Fuel and Power*),

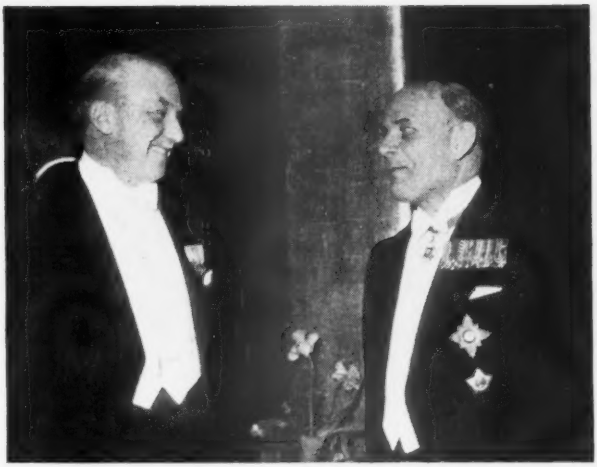


The President chats with Mr A. C. Hartley, President of the Institution of Mechanical Engineers

E. A. Berthoud, C.M.G. (*Foreign Office*), V. S. Butler, C.M.G., (*Ministry of Fuel and Power*), W. L. Buxton, M.B.E. (*Ministry of Labour*), Dr R. Cockburn, O.B.E. (*Scientific Adviser, Air Ministry*), W. R. J. Cook (*Chief of Royal Naval Scientific Service*), Dr H. Roxbee Cox, (*Ministry of Fuel and Power*), Colonel J. B. Cossens, M.B.E., H. W. Cremer, C.B.E., M.Sc. (*Royal Institute of Chemistry*), Air Chief Marshal Sir William F. Dickson, K.B.E., C.B., D.S.O., A.F.C. (*Air Member for Supply and Organization*), Lt-Col. H. S. Ebben (*Manchester Oil Refinery Ltd.*), B. J. Ellis, O.B.E. (*Oil Industries Club*), Sir Neil Hamilton Fairley, K.B.E. (*The Royal Society of Tropical Medicine and Hygiene*), Sir Donald Fergusson, G.C.B. (*Ministry of Fuel and Power*), Sir Lewis Fermor, F.R.S. (*The Institution of Mining and Metallurgy*), Dr G. E. Foxwell (*The Institute of Fuel*), Sir Harry Garner, K.B.E., C.B. (*Ministry of Supply*), W. T. Gill (*Society of British Aircraft Constructors*), Sir Frederick Godber (*Shell Petroleum Co. Ltd.*), J. C. Gridley (*Vacuum Oil Co. Ltd.*), A. C. Hartley, C.B.E. (*Institution of Mechanical Engineers*), Sir Harold Hartley, K.C.V.O., C.B.E., M.C., F.R.S. (*Institution of Chemical Engineers*), The Hon. F. J. Hopwood (*Shell Petroleum Co. Ltd.*), E. F. E. Howard (*Council of British Manufacturers of Petroleum Equipment*), B. R. Jackson (*Anglo-Iranian Oil Co. Ltd.*), R. Kelf-Cohen, C.B. (*Ministry of Fuel and Power*), Rt. Hon. Lord Kennet of the Dene, P.C., G.B.E., D.S.O., D.S.C., Dr G. M. Lees, M.C., D.F.C., F.R.S. (*The Geological Society*), J. Lesimple (*Association française des Techniciens du Pétrole*), Prof. K. Mason, M.C. (*Professor of Geography, Oxford University*), Sir Godfrey Mitchell, F. Montgomery (*Admiralty*), Dr W. L. F. Nuttall, D.F.C., (*Ministry of Fuel and Power*), Howard W. Page (*Esso Petroleum Co. Ltd.*), Sir Eric Rideal, M.B.E., F.R.S. (*The Chemical Society*), H. A. Sargeaunt, O.B.E. (*War Office*), E. E. Soubry (*Standard Oil Co (New Jersey)*), C. M. Vignoles (*Shell Mex & B.P. Ltd.*), S. J. Vos (*Trinidad Leaseholds Ltd.*), Dr. O. H. Wansborough - Jones, C.B., O.B.E. (*Principal Director of Scientific Research (Defence), Ministry of Supply*), Sir Laurence Watkinson, K.B.E., C.B., M.C. (*Ministry of Fuel and Power*), S. J. Webb-Johnson.

Among the members of Council

(Left to right) *Dr R. Cockburn, H. C. Tett, Sir Neil Hamilton Fairley, Lt-Col H. S. Ebben, V. S. Butler, Howard W. Page*



Air Chief Marshal Sir William F. Dickson (right) *and the President*

present were: (*Past-Presidents*) Lt-Col. S. J. M. Auld, O.B.E., M.C., E. A. Evans, Prof. F. H. Garner, O.B.E., (*Vice-Presidents*) M. A. L. Banks, E. J. Dunstan, Dr E. B. Evans, Prof F. Morton, J. S. Parker, H. C. Tett, (*Members of Council*) W. S. Ault, C. D. Brewer, F. L. Garton, H. S. Gibson, C.B.E., E. LeQ. Herbert, N. E. F. Hitchcock, H. Hyams, I. McCallum. H. E. F. Pracy, D. L. Samuel, R. B. Southall, E. J. Sturgess, O. F. Thompson, O.B.E., G. H. Thornley, A. T. Wilford, C. S. Windebank.

"*The Petroleum Industry*"

Marshal of the Royal Air Force, The Lord Tedder, G.C.B., D.C.L., LL.D., said he had derived great enjoyment from playing with the petroleum industry's wonderful vocabulary and was almost on Christian name terms with those three lovely sisters — Ethyl, Methyl, Butyl—who reminded him of Nebuchadnezzar's unsuccessful attempts at pyrolysis in his vain hope that he would crack Shadrach, Meshach, and Abed-nego.

He would have declined the honour of proposing the health of the petroleum industry had he not thought that everyone had ample reason for wishing it good health for what it had done and was doing for society, and also good reasons for having faith in its ability to maintain its health.

Lord Tedder said he had wondered how many had realized the vital part the industry played in the late war. There might be some who do realize that Rommel's fate was sealed by oil starvation before El Alamein was fought or that the Luftwaffe was grounded because of the destruction of German oil plants, but how many had any idea of what went on behind the scenes from laboratory to supply bases.

None had served their country better than the aero engine designers and makers, but coupled with them must be the petroleum chemists, technicians, and engineers whose courage and skill made it possible to get more and more power out of those engines. There had never been such an Oliver Twist as the airman but his demands for more and more horses out of his engines were always met.

The great and immediate problem facing Britain at present was that of

increasing productivity per head of population. If it was true that the output per American worker was almost twice that of the British worker, it was not because the American worker was better or worked harder. The power available for the American worker was almost twice that available to the British worker and oil had now outstepped coal as a source of energy in the States. Stressing the need for economy in power provision, Lord Tedder said that a few days before Britain had been pilloried by a United Nations body for wasteful use of coal and consequent waste of manpower. In using up its oil the world was living on capital which had to last until some other source of energy had been taken into use.

The other immediate world problem was the threat of mass starvation. Mechanization, made possible by oil, was contributing towards increased agricultural productivity, but did not the main solution of the food problem lie in the chemical field? There was no time to waste.

Concluding, Lord Tedder said: "When I began my remarks this evening I spoke of my contacts with the industry. During that time I did acquire a very genuine respect and admiration for the industry which I still retain. It is true I criticized the British oil industry, and would now criticize it still more strongly for unnecessary reticence or misplaced modesty regarding its achievements both in the past and during the present. How many people realize that it was British initiative, vision, and courage that first opened up the majority of the world's oilfields—Trinidad, Argentina, Iraq, Egypt, Persia, Burma, Borneo? Equally, how many people realize that British teams have not once but on a number of occasions during the past few years evolved and put into use processes which in their respective spheres have led the world?

"I venture to raise the Union Jack here, not in any exclusive nationalistic sense, but because I feel that failure to advertise the British contribution leads to the impression that the industry is either American or Dutch whereas in fact the strength of the industry lies in the fact that it is at heart international; it is because it has a sense of world responsibility, something akin to an international conscience, that I had and have faith in the industry. Not that I'm for a moment suggesting that any oil concern was given to being sentimental. On the contrary in negotiations I met no tougher customers but the toughness was not obstinacy and was always conditioned by an underlying sense of national and international responsibility. That was why it became possible for three cut-throat rivals to collaborate wholeheartedly and frankly to design, build, and operate the great plant at Heysham-Trimpell (the name was my own invention and probably my only *real* contribution). It is the same sense of mutual responsibility to the world at large which led to the joint project at Kuwait and has enabled the effect of the political upsets of recent months to be cushioned. No, to put it briefly I have faith in the industry's vision and skill, in its sense of responsibility, and in its ability to meet and solve some of our world's most urgent and vital problems, and I do with honesty and without hesitation ask you to drink, to think and to act for the good health of the oil industry, and if you ask me to prove my faith I would say that you have here in Leonard Sinclair a living example of what I mean, that synthesis of loyalties, to firm, to industry, to country, to civilization, which inspires complete confidence."

The toast was received with acclamation.

Mr L. Sinclair, replying to the toast, said that Lord Tedder had paid a generous tribute to the petroleum industry.

The recently-concluded arrangements in the Middle East had demonstrated

(Left to right) *E. A. Evans, J. Lesimple, Sir Eric Rideal, Prof. F. H. Garner, Sir Harry Garner, Maj-Gen. W. E. V. Abraham*

the value of personal negotiation. The members of the Institute should feel proud that their President was personally responsible for the very fair deal with the Ruler of Kuwait, and that the president-elect, Mr H. S. Gibson, had negotiated the agreement with the Iraq Government. These were accomplishments of historic importance.

With this subject in mind he was sure they sincerely hoped that the patient efforts of their Anglo-Iranian friends would meet the success they deserved and that a satisfactory solution would be found.

If we in Britain are to maintain, let alone improve, our standards of living, we must increase output of needed goods and services and correct our adverse trade balance. The problem was receiving most searching attention from all concerned. The contribution to the improvement in the national economy which was being made by the increase in home refining was generally recognized, thought Mr Sinclair, and was not confined to petroleum—the production of sulphur and other basic materials would be invaluable to other industries. Most new plants were capable of expansion and additional facilities would no doubt be added from time to time.

One of Britain's basic problems was the provision of increased supplies of all forms of energy. More coal and more oil were needed and those primary sources of energy were entirely complementary.

In the United States 150 million people were using 45 per cent of the world's energy from fuels, the Western European nations with 300 million were using 11 per cent, and Asia with nearly 1300 million population barely 1 per cent. Such figures served to explain the varying standards of living.

The outlook for a rapid expansion of coal was not promising, continued Mr Sinclair, but oil could make a bigger contribution to filling the gaps in energy requirements if petrol could be relieved of the influences restricting its consumption. Because petrol production was limited, supplies of heating and fuel oils were automatically restricted. Increased supplies of fuel oils would release coal for export and bring a credit to foreign exchange.

Lord Tedder had referred to the

flexibility of the oil industry which, said Mr Sinclair, had come about not by accident but was the direct outcome of vigorous and healthy rivalry between oil companies ready to accept enormous risks. It had been the result of adequate incentives for capital, for management, and for labour.

There appeared to be a tendency to-day to minimize this dynamic spirit and to fear the results of competitive enterprise.

Mr Sinclair said he believed that to achieve the most good for the most people they should be given the maximum freedom to compete among themselves. It was essential that they should not only conduct their affairs in the interests of people but also be seen to be an entirely human enterprise.

If they expected certain privileges and freedoms they should at least give the people concerned an opportunity to know who they were, what they were, and how they went about their business. This, Mr Sinclair thought, was a task to which the Institute of Petroleum might like to devote some attention, and he continued: "Obviously the work of the Institute in providing a meeting place for technologists is of vital importance but, to my mind, if the oil industry does not keep the general public informed of the broad pattern of its operations we risk public mistrust and suspicion and these, in their turn, may deservedly result in an increasing measure of external control and restrictions".

Dealing with the responsibilities of the industry in the sphere of human relations, he said it was not enough for companies to provide financial rewards only in return for work, and went on: We must endeavour to provide every single employee with opportunities to feel he or she has a personal participation in our business and, therefore in the welfare of our country.

"We must encourage all our people to acquire a definite sense of individual achievement and to secure for themselves the satisfaction that comes from a job well done, without which work has little or no interest and even becomes a drudgery."

Care must be taken that the clarion call for greater productivity was not ignored by any one of them. Some thought it applied only to the coal workers and perhaps to the steel workers, and maybe to the agricul-

(Left to right) *The President, Vice-Admiral The Hon. Sir Denis Maxwell, and Major-General John P. McConnell*

tural workers—but it applied equally to oil workers, including those present that night.

Concluding, Mr Sinclair said: "We must not sit back with any feeling of superiority or with smug satisfaction. We must not rest on those laurels bestowed on us by Lord Tedder.

"We should remember that our predecessors could claim a great deal of the credit for our progress to date.

"To my mind we shall never get to the root of this very basic problem until we recognize that productivity is the outcome of good management, and is the responsibility of management.

"Administrative ability has been defined as the ability to get people to co-operate in the common purpose of an enterprise.

"The job ahead of us is bigger, by far, than anything we have yet attempted and it calls for good leadership, genuine consultation with labour, imagination, and continued creative technical development.

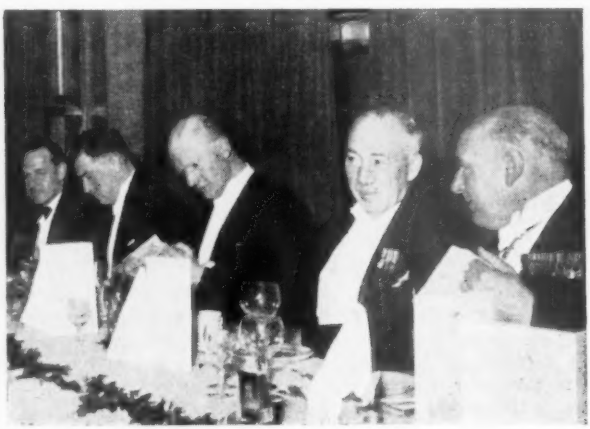
"With these qualities, and with enthusiasm and honesty of purpose, we can earn those laurels and become entitled to wear them."

"The Guests"

Mr C. A. P. Southwell, M.C., President of the Institute, expressed his pleasure in welcoming the guests on behalf of the Council and members of the Institute and in proposing their very good health.

They had all listened with great interest and appreciation to Lord Tedder and it was appropriate to pay a special tribute to "our men of the air". It was fourteen years since Lord Tedder had honoured them by his presence on a similar occasion. History had been made in the interim years and in that Lord Tedder had played an important part (hear! hear!)

In the fourth volume of his war memoirs Mr Churchill quotes a letter he wrote to Lord Tedder in which he said: "Here at home we are watching with enthusiasm the brilliant supreme exertions of the Royal Air Force. We are sure you will be, to your glorious army, the friend that endureth for ever". Lord Tedder's reply, after thanking the Prime Minister for his encouraging words, ended, "We are at full throttle and determined to make a good job of it".



(Left to right) *Prof. Frank Morton, E. F. E. Howard, R. J. Ayres, J. S. Parker, G. E. Foxwell*

What a glorious Elizabethan age we could have, said Mr Southwell, if only everyone would take this as his motto and stick to it (hear! hear!)

Mr Southwell said it was not possible for him to welcome by name all the distinguished guests, but they were glad to have with them Air Chief Marshal Sir William Dickson, who carried a great responsibility at the present time.

They welcomed Sir Donald Fergusson, head of the Department with which the petroleum industry was most closely connected, and his colleagues; and they were glad to have with them the heads of the scientific sides of the Navy, the Army, and the Air Force, and of the Ministries of Supply and of Fuel and Power. He congratulated Dr Roxbee Cox of the latter Ministry on the recent award of the James Clayton prize of the Institution of Mechanical Engineers.

It had been said that the only constant factor in our 20th century industrial and scientific developments was "change" and great as the momentum had been in the first half of the century it was likely to be even greater in the second. The Institute wanted to see technology, the scientific Cinderella, proceed to a brilliant future and to ensure a quicker adaptation of new scientific discoveries to industry. Why should British findings so often lead to more developments abroad than at home?

The scientific and technical societies had helped to build up Britain and provided a valuable service to our younger men. They were therefore appreciative of the presence that evening of a number of presidents of these societies, said Mr Southwell, and of the president-elect of the corresponding institute in France, the Association française des Techniciens du Pétrole.

They also welcomed Sir Neil Hamilton Fairley, president of the Royal Society of Tropical Medicine and Hygiene. Medical officers in the petroleum industry had done great missionary work in the humanitarian field and in tropical research but never received the credit they deserved.

A hundred years ago the product of the petroleum industry was largely medicinal and rock oil was advertised in Pennsylvania as:

"The healthful balm from Nature's
secret spring
The bloom of health and life to man will
bring,
As from her depths the magic liquid flows
To balm our sufferings and assuage our
woes"

It was to be hoped, continued Mr Southwell, that before long Nature's spring would bring real benefit to the affairs and people of the Middle East, but it would need statesmanship of a very high order.

They were very glad to welcome the Engineer-in-Chief of the Royal Navy, Admiral Sir Denis Maxwell, and to congratulate him on receiving the accolade that morning from Her Majesty. They looked forward to hearing him in response to the toast.

They were always pleased to welcome their American friends, guests and members, many of whom came from Texas, but General McConnell, whose name was also coupled with the toast, came from Arkansas. The word "Arkansas" meant peace and he was sure that if anything could achieve peace it was British-American co-operation.

Finally, Mr Southwell said, that thanks to the co-operation of the petroleum companies, the Institute was in a healthy state financially and otherwise. They appreciated the support which the chairmen and directors of all the important oil companies had given them and their presence that evening was very gratifying.

He also took the opportunity, his last as president, of thanking the General Secretary and the staff of the Institute for the work they had done during the year.

The President then asked the members to drink the health of their guests,

coupled with the names of Admiral Sir Denis Maxwell and General John P. McConnell.

Vice-Admiral (E) The Hon. Sir Denis Maxwell, K.C.B., C.B.E., R.N., responding to the toast, said he felt it a great honour to have been asked to do so.

It was well known, he said, that Lord Fisher was the moving spirit in the decision to adopt oil as the fuel for the Navy. Lord Fisher had foreseen the change for many years before the turn of the century and so, apparently, had a certain Italian, Signor Ferrari, who wrote to the Board of Admiralty in 1895 as follows:

> "The system of petroleum being highly humanitarian and England being a nation which fights against slavery with all its might (a fact which is greatly to the advantage of humanity)—I beg to offer my system.
>
> "The most human thing your excellencies can do is to adopt my system which has the advantages of a safety pipe which, should it happen to be pierced by a projectile, will give warning of the damage by means of an electric bell. Thus these most able and vigilant men, the engineering personnel and those poor white slaves the stokers will be saved!"

Sir Denis said that fortunately the Admiralty did not go back on its decision to burn oil instead of coal. Oil had given mobility to the Fleet and was now the lifeblood of the nation. In 1944 the Navy used roughly three times the amount of oil used in 1917 and developed twice the horse-power per ton. So they had done their bit towards economy.

It was fifty years since approval was given "to erect two experimental brick furnaces in Haslar Gunboat Yard for the purposes of studying the combustion of liquid fuel", to found the Admiralty Fuel Experimental Station. Work had continued at Haslar ever since and the steady improvements in oil burning equipment had resulted almost entirely from that work.

Sir Denis then referred to the work of the Admiralty Oil Quality Committee and thanked the chairmen of the oil companies for sparing senior members of their staff to work on that Committee, its sub-committees, and panels. He also thanked the laboratories up and down the country for the work they were doing on the problems which had arisen, and the independent members.

After expressing the thanks of the guests for the hospitality they had received, Sir Denis said "Thank you also, Mr President, for your remarks on the honour I received to-day. I have never before been so impressed by such an amazing combination of dignity and charm in any one person. I thank you for having invited me to so pleasant a function at the end of a day which has been unique in my life."

Major-General John P. McConnell, U.S.A.F., also replied to the toast. He said that in addition to being a guest he also represented a large group of customers, namely military aviation. In any business a good producer-customer relationship was essential and the only difference in the relationship which would normally obtain in any business and the relationship between military aviation and the petroleum industry was simply "With fuel we fly—without fuel we don't fly".

As aviation, and particularly military aviation, moved into longer ranges and heavier aircraft requiring increased fuel consumption and higher quality fuel, it was dependent on research and development by the petroleum industry and on storage in large quantities at strategic locations.

The wide range of fuels, including three jet fuels, gave the U.S.A.F., the Air Ministry, the petroleum industry, and the British Government a terrific problem in storage, delivery, and security. It was only by the closest co-operation between them all that they managed to keep abreast of the problem, said General McConnell.

The U.S.A.F. intercontinental bomber—the B.36—carried 30,000 U.S. gallons of fuel and at operational speeds and heights consumed 1000 U.S. gallons per hour. In the U.K. alone, on a very small scale peace-time operation, the U.S.A.F. was consuming aviation fuel at the rate of 53 million Imperial gallons a year.

The petroleum industry was nearly entirely responsible for improvements in jet fuels, continued General McConnell. JP-1 was a well-refined kerosine fuel but the potential supply was only about 3 per cent of the average crude, JP-3, a gasoline-fraction fuel was then developed with a potential availability of about 60 per cent of average crude. But it had a high vapour pressure and consequently a large percentage was lost in flight by evaporation. So the petroleum industry developed JP-4, the availability being estimated at 40-45 per cent of the crude and the Reid vapour pressure was 2 or 3 pounds.

Concluding, General McConnell said: "In research, in production, in distribution, in storage, in re-distribution—and in the insurance of security from sabotage or accident during all these processes—military aviation and the petroleum industry must continue to work together with the utmost harmony and understanding. Since the United Kingdom and the United States are the leaders of the world in the petroleum industry, it is essential that Anglo-American relationships continue to be in utmost accord.

"It is my understanding that these relationships in the petroleum industry are outstandingly satisfactory. I have no experience in that area but I can tell you that complete Anglo-American relationships can be achieved. This achievement has been effected between the Royal Air Force and the United States Air Force. We work so closely together and we understand each other's problems, capabilities and limitations in such detail, that for those of us in the one service who are associated constantly with the other service, it is to all intents and purposes the same outfit. I can tell you truthfully from the standpoint of experience, that there is no relationship between any two forces of any two nations in the world comparable to that which exists between the Royal Air Force and the United States Air Force.

"I am in command of more than 30,000 United States troops in the United Kingdom. The hospitality which has been accorded us by the British people and the assistance which has been rendered to us by those at all levels of the Royal Air Force from top to bottom, is absolutely amazing; we are most grateful. I do not believe there has ever been a time in the history of the world when the armed forces of one major power have been stationed in the territory of another in time of peace without some sort of formal agreement. There is not yet any formal agreement that I know of that permits us to be here. We are here informally, but the reception we have had and the assistance we have received makes us feel that we are welcome.

"I am sure that from what I have heard the relationship between the petroleum industries of our two nations is of the same nature and it is my further information that the Institute of Petroleum has been a great factor in establishing and maintaining this understanding."

This concluded the proceedings.

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SPELL-BOUND

Bine, dine and fine, kine, line and mine,
With nine, pine, sine, tine, vine and wine,
Will make me talk of "kerosine."
If it's rhyme with dene and gene
I ought to spell it "kerosene."
The Scots, the O.D., ads and sin
Would let me spell it "paraffin."
With such a choice I'm bound to err. O,
Here's a way ; I'll spell it "kero."

ANON.

NEW PUBLICATIONS FROM MOR

"Some Economic Aspects of the Oil Industry in 1951", a study of present and future trends prepared by Georg Tugendhat and Catherine Mackintosh, has been issued by Manchester Oil Refinery and Petrocarbon Ltd. as a supplement to their magazine *Oil*. The authors examine the present economic structure of the industry and suggest a revised pattern for future development.

Another new publication from the same company, titled "Building a Petroleum Chemicals Plant", describes the construction of Petrocarbon's Manchester plant. In it are reprinted three papers dealing with the engineering aspect (H. E. Charlton), fuel, heat, and power aspects (E. Bonwitt and H. E. Charlton) and chemical engineering aspects (H. E. Charlton). More than 70 figures and half-tone illustrations are included, as well as a flow sheet.

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BUBBLE PLATE RESEARCH

It is announced by the Research Committee of the American Institute of Chemical Engineers that, after studying the necessity of a research programme in bubble plate efficiency, a basic programme has been developed to study the effect of tray design and system properties on tray efficiency both in fractionation and absorption.

The programme calls for variations in column size and tray spacing over a wide range of pressures and systems. This will permit evaluation of the individual effect of the gas and liquid phases on separation efficiency.

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Conserving Steel. "How to make a drill-pipe last longer," a pocket-sized booklet issued by the National Supply Co., Pittsburgh, Pa, U.S.A., explains with the aid of cartoons the principal destructive factors that act on drillpipe and recommends handling and drilling practices which help to prolong the life of a pipe.

PERSONAL NOTES

Managerial changes at Esso Development Co include the appointment of **T. R. Bird** (Fellow) as general manager, a new position. Mr Bird is succeeded in his former post of manager of Esso European Laboratories by **Dr T. K. Hanson** (Fellow). **D. H. McLean** has been appointed section head, Fuels Research Section, and **Dr A. Winward** (Assoc. Fellow) group leader, Development Group, in place of **E. B. V. Potter,** who has taken over the Motor Fuels Group.

Dr Ernest W. Dean, F.Inst.Pet., was recently presented with a 30-year service award by the Standard Oil Development Co., of which he is consulting chemist and vice-president of the Products Committee. Dr Dean joined Standard Oil Co (N.J.) in 1922 as director of their Standard Inspection Laboratory, having previously been head of the petroleum laboratory at the Pittsburgh Experimental Station of the U.S.B.M.

D. M. Glendinning, B.Sc., A.M.I.C.E., F.Inst.Pet., has been appointed manager of Vacuum Oil Company's new refinery at Coryton, Essex. He first entered the industry in 1925 at the Suez refinery of the Shell Group and has held the posts of chief engineer and deputy refinery manager for Lobitos Oilfields Ltd., chief engineer for Anglo-Egyptian Oilfields Ltd., and chief engineer for Fina Petroleum Products Ltd.

★ ★ ★

Arc Welding Electrodes. Technical information, with illustrations, graphs, and tables on the theory and application of welding electrodes is contained in a brochure on the "48" electrode available from Philips Electrical Ltd., Century House, Shaftesbury Avenue, London, W.C.2.

AROUND THE BRANCHES

London Branch

On the evening of February 20, the Branch had the honour of an address by the President of the Institute at Manson House. Mr Southwell's subject was "The Oil Pioneer". The Branch Chairman, N. E. F. Hitchcock, was in the Chair.

The President described some of the difficulties and hardships, technical, topographical, and climatic, which had to be overcome by those who, in the early days of the industry, sought out and proved the fields from which the oil later flowed to found the industry's fortunes. Mr Southwell illustrated many of his points with interesting slides, and by drawing on his own early experiences, particularly when he was Government Petroleum Officer in Trinidad. He then went on to remind his audience that in spite of the great progress and growth of the industry, the continued supply of oil still depends, to a very great extent, on the unremitting effort of the oil pioneers to discover new sources which, all too frequently, lie in uncomfortable and more or less inaccessible terrain. A graphic illustration of the sort of conditions which to-day's oil pioneers have to face was provided by a film showing the search for oil in the jungles of New Guinea; the film included a fascinating sequence showing everything that should not be done when landing a flying boat, from the moment of touching down, right to the final heartrending crash into the river bank.

A number of additional points were raised in the discussion following the President's talk and the meeting ended with a very hearty vote of thanks proposed by the Chairman, N. E. F. Hitchcock.

Northern Branch

At the meeting held at the Engineers' Club, Manchester, on February 19, 1952, a lecture was given on "The structure of lubricating grease as revealed by modern laboratory methods and technique". In the absence of the author, J. B. Matthews, through illness, the paper was read by D. Evans.

The author reminded the audience of the common saying that the manufacture of grease is an art, and suggested that, whereas that might have been true ten years ago, the position was rapidly changing to-day. Indeed, as the result of a considerable amount of scientific activity during the past fifteen years, quite a lot is now known about the structure of lubricating greases, and the properties of lubricating greases can be controlled and modified by applying this knowledge in the right way.

This knowledge had been accumulated by numerous workers, mainly by the application of new experimental techniques and instruments, and the object of the lecture was to co-ordinate their findings and to present them in a way which would reveal the modern views concerning the structure of lubricating greases.

The story commenced with Lawrence's exploratory studies of gels formed from metal soaps and hydrocarbon oils, in which the main emphasis had been placed on the changes which occur in the solid phase structure as the temperature is varied. Lawrence's work was followed by the systematic investigation of hydrocarbon-oil/soap phases by numerous investigators on a more quantitative basis, notable amongst whom have been Vold and his collaborators, who extended to non-aqueous systems the classical work of McBain on aqueous soap systems.

An important experimental technique used in these phase studies is that of calorimetric differential thermal analysis. The kind of apparatus used in the author's laboratory was described, and the results obtained on different soap/hydrocarbon-oil systems were given.

The conclusion reached was that thermal analysis can provide useful information concerning the crystalline structures which soaps can assume in greases under different conditions of temperature and concentration, but that otherwise they do not throw much light on the structure of the grease.

Some of the earliest recorded photomicrographs of greases were published in 1936, and although these revealed the essentially fibrous nature of greases, little interest appeared to be taken in this side of the work until the advent of the electron microscope ten years later. Several slides of electron micrographs were shown, illustrating the elementary soap fibres which exist in greases, but a warning was given that, although these fibres (which cannot be seen by the light microscope) can be regarded as the "bricks" which make up the grease, the grease structure itself can probably not be observed by the electron microscope. To obtain an insight into the structure assumed by the soap fibres in a grease, the light microscope is invaluable, and further slides illustrated how the organization of the fibres in a grease can affect its properties.

The shape and size of the fibres, however, do also play an important part in determining the properties of a grease, and with a given soap and oil they are the most important factors. It was stressed that the "fibres" observed by the light microscope or "sensed" from the texture of the grease are not the true fibres observed in the electron microscope, but are organized aggregates of these fibres.

The lecture concluded with an account of how a new and improved process for the manufacture of lithium greases has been developed by the direct application of the sort of fundamental information described.

Seventy-two members attended and a stimulating discussion followed the paper. E. A. Evans, past-president, proposed a vote of thanks to author and reader.

Scottish Branch

On February 14, at a meeting held in Edinburgh, R. G. S. Avery of Anglo-Iranian Oil Co., addressed the Branch on "The Pipeline across Scotland". James T. Guthrie was in the Chair.

The author explained that when it was decided to increase the throughput at Grangemouth Refinery it became necessary to provide additional facilities for taking in crude oil. The choice lay between dredging the River Forth so that it would take the new 28,000 ton tankers or providing another suitable port together with a means of transporting the crude from that port to Grangemouth. Economic reasons showed that it was best to adopt the latter method and that the transportation problem was most efficiently solved by using a pipeline between Finnart, the new port and depot, and the refinery at Grangemouth.

The depot essentially consists of an oiling jetty, storage tankage, and forwarding pumps, but a number of other ancillary necessities are also provided. Among these the most important are bunkering tanks for fuel oil and diesel oil, water supplies for both the depot and supply to ships, a boilerhouse for supplying steam heat to the fuel tank and fuel pipelines, an office building, a garage and workshop, and a firemain pumphouse. Finnart depot is situated on the sloping hillside to Loch Long and all of the tanks are surrounded by large bunds to retain any spillage that might occur. In some cases these are entirely of earth with grassed slopes but in others reinforced concrete retaining walls up to 17 ft high have been built so as to confine the base area of the bunds. To provide the maximum safety all the tanks have been fitted with floating roofs which rest on the top of the crude oil in the tanks and thus prevent the formation of any gases. Added to this is an elaborate fire-fighting system with a large capacity pumphouse providing sea-water to a ring main:

trailer pumps and foam apparatus provide cover for every part of the depot. As a further precaution the fire pumphouse, which is situated away from the tankage area, has both electrically driven pumps and pumps powered by internal combustion engines.

The pipeline from the depot to Grangemouth crosses much moorland country so as to avoid built-up areas as much as possible. The design is based on very low wall stress of 17,600 psi in order to provide yet another factor of safety. To this end solid drawn tubing 12.75 inches external diameter with a wall thickness of 0.330 inches has been used. The total length of the pipeline is just over 57 miles, and it was completed between June 1950 and March 1951. Throughout its length the pipeline is buried with at least 2 ft of cover even where rivers, roads, and the Forth/Clyde canal are crossed. In the cases of all waterways and major roads, the pipe is encased in a larger diameter pipe to provide additional strength and protection.

After completion the line was subected to a comprehensive testing period which consisted of a static pressure test with water to 900 psi, and the passage of a 'go-devil' through the whole length of the line. The 'go-devil' is used to ensure that the line is clear of obstructions and to clean the inner walls of wax etc., which might be deposited over a period of time. The 'go-devil' is propelled along with the fluid being pumped and a check on its position is kept, not only by recording the quantity of oil pumped after insertion in the line at the depot, but also by means of a radio-active isotope attached to the 'go-devil'. Radiations from this can be picked up by a geiger counter held close to the ground above the 'go-devil'.

As a precaution against corrosion the pipeline is wrapped with a bituminous coating approximately $\frac{1}{4}$ inch thick and is also protected cathodically. In this latter method blocks of magnesium are buried alongside the pipe at approximately 200-yard intervals and connected to it by insulated cable. These blocks then corrode instead of the pipe and it is estimated the life of the pipeline can be indefinitely prolonged by the efficient maintenance of these two precautions.

South Wales Branch

A film show lasting two hours was held on January 11, and was enjoyed by all present, perhaps because the films screened were not completely technical. The films shown were first a short feature, Anglo-Iranian's Oil Review No. 13. The main film was *The Louisiana Story*, Robert Flaherty's well-known documentary.

The Annual General Meeting was held on February 7, under the chairmanship of the Branch Chairman, E. S. Squire. The usual formal proceedings were carried out first, after which the meeting was thrown open for general discussion.

The proceedings lasted two and a half hours and as a "free for all" went a long way to enhance the prestige of the Institute.

As a footnote it is worthy of recording that since this meeting there have been 29 applicants for local, 16 for student, and 4 for corporate membership.

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STAINLESS STEEL PRODUCTS

The official directory recently issued by the Stainless Steel Fabricators' Association of Great Britain gives information regarding the members of the Association and the products which they manufacture. There is a foreword by Viscount Kemsley and a short history of the development of stainless steel since 1766. Price of this book of 136 pages is 10s 6d and copies are obtainable from The Eagle Press Ltd., 32 Great Queen Street, London, W.C.2.

MODERN TECHNIQUES IN PETROLEUM TESTING

IX. MECHANICAL TESTS FOR LUBRICATING GREASES

By **S. R. PETHRICK***

The behaviour of a grease in service is dependent on its initial flow properties and on the degree to which those properties are retained under the operating conditions. In the future it is possible that rheological tests in conjunction with chemical tests will permit the evaluation of greases in terms of fundamental properties but at the present time simulated performance tests are necessary for an adequate assessment of quality.

Mechanical Working Tests

The structure of most greases is built up from soap fibres in either a twisted or untwisted condition and the consistency of the lubricant is dependent on the fibre length to diameter ratio. During service in a bearing the soap fibres become shortened and in some cases less twisted, with the result that the characteristics of the grease are altered. In the simpler mechanical tests it is usual to assess stability by consistency measurements before and after subjecting the grease to some form of working. In order to measure the consistency it is necessary to use a fairly large amount of grease and, as a consequence, the degree of breakdown achieved in the working test is smaller than is the case when a very thin film of grease is sheared in a bearing.

The well-known worked consistency test for greases originally employed a manually operated worker which forced the sample through a number of $\frac{1}{4}$-inch diameter holes in a plunger disk. Consistency measurements were made after sixty complete strokes of the plunger. The manual operation of the plunger was an arduous task particularly with the harder greases and equipment eventually became available to permit mechanical operation of the plunger. The advent of the mechanical equipment led to investigations into the effects of prolonged working and tests employing up to 100,000 strokes of the plunger are now incorporated in some grease specifications. A typical mechanical grease worker is shown in Fig. 1. The plunger disk attached to the operating rod on the component shown in the foreground of the photograph is drilled with holes 1/16-inch in diameter. This modified disk is employed for the more severe working conditions specified in DTD 825 and in certain U.S specifications.

In tests on a number of ball- and roller-bearing greases the increase in penetration caused by working for 10,000 strokes varied from 8.5 per cent for a lithium base product to 300 per cent for a soda base grease. Despite its comparatively poor performance in the working test, service experience showed the soda base grease to be a satisfactory lubricant for ball bearings operating at medium speed. The lithium base product on the other hand showed considerable oil separation on heating to

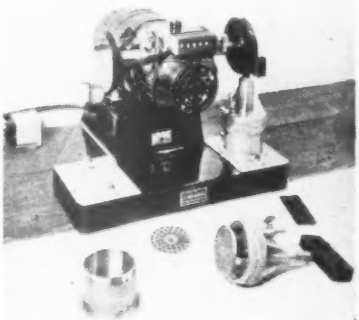


Fig. 1

* Anglo-Iranian Oil Co.

temperatures of the order of those at which ball bearings are sometimes operated. The mechanical working test would thus appear to be an unreliable guide to the quality of a grease.

A simple mechanical test which simulates operating conditions more closely than the above grease working test is that known as the Shell Rolling Stability test. The equipment consists of a rotatable hollow cylinder containing a weighted roller. Approximately 75 grams of grease are placed in the cylinder, the roller inserted and the apparatus rotated for four hours at 160 r.p.m. The changes in consistency produced by the working of the grease are measured by a means of micro-penetrometer. The test produces greater breakdown of the sample than can be achieved with the conventional grease worker but the results tend to be less reproducible.

The tests described above are suitable for the routine examination of greases but many of the mechanical tests devised in recent years are of utility for type approval purposes only. Following the practice of many anti-friction bearing manufacturers, type approval tests are being incorporated in official specifications.

High Temperature Performance Tests

Specification DTD 783 incorporates a test in which the main rotor bearings of a Rotax N.S.E. 12-6 ml or N.S.E. 12-7 magneto are lubricated with 1.0 g of grease in the cam end bearing and approximately 0.6 g of the same grease in the drive end bearing. The magneto is run at 4500 r.p.m. with spark gaps set to discharge at 9kV. During the run the mounting flange is maintained at 100°C, with the surrounding air temperature at a minimum of 15°C. The test is run for a total of 1000 hours in non-stop periods of not less than 150 hours. Duplicate tests are carried out and the grease is considered to be satisfactory if no bearing fails before the runs are completed. If one failure occurs a third run is made. The test is essentially a service trial and ensures that the catalytic effects of ozone and the oxides of nitrogen are allowed to play their part in the breakdown of the grease.

High temperature and high speed conditions are employed in a performance test included in specification DTD 825. The test, which is based on a method described in U.S. Specification MIL-G-3278, utilizes a BRL.020 bearing as the essential component of the apparatus. The test bearing is mounted in a housing and located as a tight press fit on a horizontal shaft. The shaft is supported on a rigid base by means of two bearings designed for operation at high speeds. The housing for the test bearing is fitted with a means for applying a radial load to it and a calibrated spring applies an axial load to the outer race of the bearing. Two thermocouples are located in the housing, one for temperature measurement and the other for temperature control. The test bearing, after filling with 3.0 ± 0.1 g of grease is mounted in an electrically-heated oven. Thrust and radial loads of 5 lb each are applied and the bearing temperature raised to 121 ± 1°C. The bearing is run continuously at 10,000 r.p.m. for twenty hours and allowed to cool for four hours. The running and cooling cycle is repeated until lubrication failure occurs or 1000 hours of operation have been completed. The test is carried out in duplicate and the grease is considered to be satisfactory if the bearings do not fail in either test. A third test is conducted if one failure occurs during the duplicated tests.

A twin high speed test unit is shown in Fig. 2. With this version of the apparatus a wattmeter is placed in the motor circuit and failure of the bearing is denoted by a sharp rise in the motor wattage. The test bearings must be carefully selected and should be manufactured to extreme precision limits and

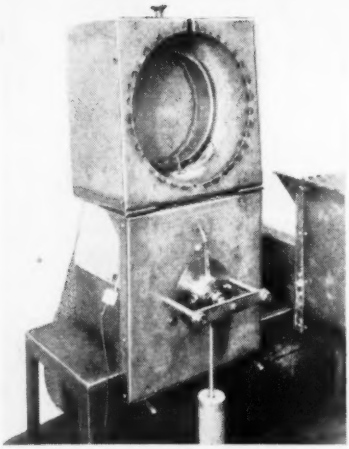


Fig. 2

tempered to run at 120°C. The main difficulty with the test is the elimination of unsuitable bearings. It must be borne in mind in testing greases that the test results may not be applicable to the operation of equipment fitted with bearings other than those of the type employed in the test apparatus.

Wheel Bearing Lubricant Tester

Equipment for testing wheel bearing lubricants has been described in the literature from time to time. The Co-operative Research Council and the American Society for Testing Materials have examined a rig known originally as the Indiana Wheel Bearing Tester. The last-named organization published a proposed method of test in 1948. The apparatus consists of a simulated automobile front wheel hub and spindle assembly driven at 440±10 r.p.m. in a heated cabinet. The hub contains an inner bearing which is packed with 3 g of grease and an outer smaller bearing filled with 2 g of the same grease. About 85 g of grease are distributed in a uniform layer on the inside of the hub with a thin film on the bearing races in the hub. A leakage collector is weighed and placed on the spindle together with the larger bearing. The hub and smaller bearing are then assembled and the assembly tightened and slackened off in the usual way until the hub rotates freely without end play. The holding nut is locked with a cotter pin and the weighed hub cap screwed into position.

The hub is rotated by a pulley and belt assembly and the temperature of the spindle raised to 220±2.5°F. The test is run for 6 hr±5 min and the apparatus dismantled while hot. Changes in consistency of the grease are observed and the amount of grease leakage determined by weighing the leakage collector and the hub cap. The bearings are washed with naphtha and inspected for the formation of gum or lacquer-like deposits.

The ASTM Wheel Bearing test has not yet been adopted as standard and it is likely that changes in the mode of operating the equipment will be made before the test is fully approved. American design of wheel bearings differ from those employed in Britain and some modification of the apparatus must be made when testing greases for use in British wheel hubs.

Water Resistance Tests

Greases showing little leakage in wheel bearing tests may give trouble in service as a result of water gaining access to the hub. Some soda base greases soften considerably if contaminated with water whilst others of a similar base are scarcely affected. There has been a trend in recent years towards the use of revolving bearings in water resistance tests. Typical of such methods is that described in U.S. Specification MIL-G-3278 and in DTD 825. For the British version of the test a BRL.020 bearing lubricated with 3.0±0.1 g of grease is rotated at 600±20 r.p.m. while a fine stream of distilled water is directed against it at a flow rate of 5 ml

per second. At the end of one hour the loss in weight of the grease is determined. The test which was designed for the examination of low temperature greases for aircraft is probably less suitable for the testing of the water resistance of wheel bearing lubricants than the total immersion method described in specification DTD 783. For the latter test the loss in weight of grease from a filled BRL.200 bearing is determined after the bearing has been rotated for 30 minutes in distilled water at 100°F.

Low Temperature Torque Test

Specification DTD 825 includes a method for the determination of low temperature torque on aircraft greases. The apparatus consists essentially of a BRL.020 bearing housed in a doubly grooved aluminium drum and mounted on an axle in a small metal box having a detachable side. The box is fitted with two vertical tubes to allow the passage of threads for the rotation of the bearing. A cross-bar carrying two pulleys of the same effective diameter as the drum is mounted at the top of the vertical tubes. The bearing is charged with 3.0 ± 0.1 g of grease and assembled with the drum in the metal box. Threads are attached to the drum and wound around it before being passed through the vertical tubes. The drum is rotated by means of the threads for a total of 100 cycles comprising one revolution in each direction. The removable side of the box is replaced to form a liquid tight container for the bearing and the assembly lowered into a liquid bath at the appropriate temperature. During the cooling period the test bearing is rotated twice in each direction at fifteen minute intervals for one hour. Cooling is continued for a further hour with the bearing in a static condition. To measure the torque the threads are passed over the pulleys on the cross-bar and a weight of 50 g attached to one thread and a weight of 700 g to the other. The rate of rotation of the bearing is measured by timing the rate of rise of the smaller weight. After allowing the bearing to remain undisturbed for a further period of 15 minutes the weights are interchanged and the rate of revolution of the bearing in the opposite direction noted.

Co-operative tests with the low temperature torque apparatus have shown that the results are not very reproducible. The use of a set screw to lock the bearing and drum is liable to cause distortion to the outer race of the bearing and a side locking device is preferable. The test gives no indication of starting torque, which is important for low powered instrument motors on aircraft, and other types of test are being considered. Low temperature torque depends to a great extent on the design of the bearings with which the grease is used and some form of yield value and rate of shear/shearing stress measurement is likely to provide a more useful guide to the low temperature behaviour of greases than can be obtained in restricted performance tests. It is doubtful whether any apparatus employing bearings can provide more useful data than those obtained with the DTD 825 apparatus.

Tests for Fretting Corrosion

Fretting corrosion arising from vibration and oscillation has caused many bearing failures in the past. With steel bearings the signs of fretting corrosion are the presence of a rouge-like substance dispersed in the lubricant accompanied by pitting of the bearing surfaces. For assessing the suitability of greases for the prevention of fretting corrosion the Fafnir Bearing Company has devised an oscillating bearing tester.

In the Fafnir test the grease is applied to a weighed pair of thrust bearings mounted on a spindle. A thrust load of 550 lb is applied by means of a calibrated spring and the bearings oscillated through an angle of six degrees at a rate of 3400 reversals per minute. After

running for fifty hours the bearings are cleaned and re-weighed. The loss in weight of the bearings gives an indication of the suitability of the grease. With good lubricants the bearing losses are less than 0.002 g per bearing whilst poor greases may be associated with losses of 0.100 g or more. The results of the tests correlate with service performance, since heavy greases cause greater fretting corrosion with the tester, and in practice, than do soft greases.

Gear Wear Test

The advent of greases based on synthetic oils has led to the development of tests to ensure that they are adequate lubricants. Specification DTD 825, following on the lines of U.S. Specification MIL-G-3278, includes a gear wear test for low temperature greases.

The apparatus employs brass and steel helical gear combinations which are subjected to reciprocating motion by means of a flexible cord attached to a shaft having a reciprocal linear motion of 3.14 inches amplitude at 50 cycles per minute. The gear assembly is first run with the gears dipping in di-2-ethyl hexyl sebacate with a 5 lb load applied to them. Gears showing losses in weight in excess of 2.0 mg per 1500 cycles are rejected. Acceptable gear sets are washed, reassembled and the teeth coated with the grease. A run of 6000 cycles with a 5 lb load is made and the loss in weight of the brass gear determined. After cleaning and re-assembly a test is made for 3000 cycles under a 10-lb load. The tests are repeated with four gear sets and the average loss in weight of the gears calculated to the nearest 0.1 mg per 1000 cycles at each test loading. Wear losses of less than 2.5 mg at 5-lb load and less than 3.5 mg at 10-lb load denote acceptable greases.

General

The tests described in this article have been selected from those which have received some degree of official approval but it must be emphasized that modifications to the equipment and mode of operation are likely to occur in the near future. In most of the tests it is necessary to follow the original design of the apparatus fairly closely if results from various laboratories are to show reasonable agreement. It is hoped that in the future it will be possible to specify greases in terms of fundamental data in such a manner that interested parties can devise their own equipment for making the tests. At the present time the trend towards mechanical tests makes grease testing expensive particularly when the equipment is liable to become obsolete within a short space of time.

★ ★ ★

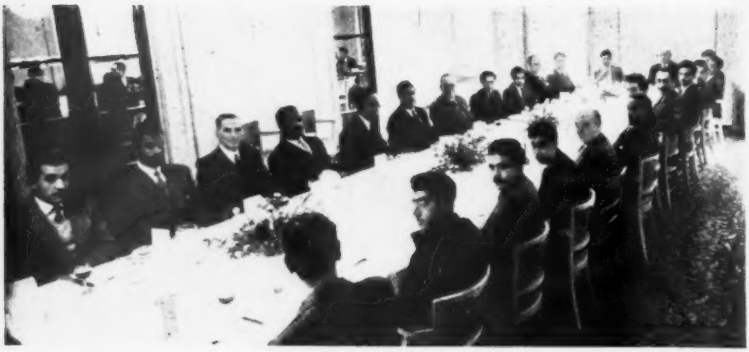
SCOTTISH SHALE

A description of the operation of the Scottish shale oil industry is given in a 32-page booklet recently published by Anglo-Iranian to bring up to date the booklet issued in 1948.

Following a brief history of the industry, an account is given of operations at Burngrange pit, at Westwood crude oil works, and at Pumpherston refinery. The manufacture is described of the main products—motor spirits, solvent naphthas, diesel oil, paraffin wax, and synthetic detergents — and also the making of building bricks from spent shale.

Copies of the booklet may be obtained from the General Department, Britannic House, Finsbury Circus, London, E.C.2.

KUWAITI STUDENTS' GATHERING IN LONDON



To celebrate the second anniversary of the accession of the Ruler of Kuwait, His Highness Shaikh Abdullah as-Salim as-Sabah, the Kuwait Oil Company invited all Kuwaiti students in Britain to a gathering held in London during the weekend of February 22-24.

Saturday was a full day. In the morning the students visited Battersea Power Station. After a luncheon party they went to Twickenham to watch a Rugby football match, Harlequins versus the Royal Navy. After dinner the students were taken to the theatre.

On Sunday, a luncheon, at which the Kuwaitis were hosts, was attended by Mr C. A. P. Southwell, Managing Director of the Kuwait Oil Company, Mr H. T. Kemp, London Representative of His Highness, and members of the oil company's staff.

★ ★ ★

CONGRESS ON ANALYTICAL CHEMISTRY

Arrangements for the International Congress on Analytical Chemistry, to be held in Oxford from September 4-9, 1952, are now practically complete and those who hope to attend are asked to advise the Hon. Secretary, R. C. Chirnside, Research Laboratories, General Electric Co. Ltd, Wembley. Registration fee for the Congress is £2.

In addition to the scientific sessions, there will be three main lectures, to be given by Dr C. J. van Nieuwenburg, Professor of Chemistry at the Technical University of Delft; Dr Ralph H. Müller, Los Alamos Scientific Laboratory, New Mexico; Dr L. H. Lampitt, Chief Chemist and Director of J. Lyons & Co Ltd.

SICILIAN OIL SEARCH

Since D'Arcy Exploration Co was granted a licence over about 90,000 hectares in southern and eastern Sicily in May 1951, intensive surface reconnaissance has been in progress. A gravity meter survey is being made to determine whether and where a deep test should be drilled.

★ ★ ★

PETROLEUM IN PARLIAMENT

Branded Motor Fuels

The Minister of Fuel and Power, in a written answer on February 27, said that the Government had decided that in the present financial and economic position premium brands of petrol could not be introduced.

SAFETY CONFERENCE

A Chemical Works Safety Conference is being held at the Palace Hotel, Buxton, Derbyshire from May 2 to 4. Papers are to be read on "Safety in the laboratory and on the plant", L. G. Burrage (I.C.I.); "Toxic dusts in industry", J. S. Evans (F.B.I.); "Relation between plant strength and dust explosion relief", Dr Matheson (Ministry of Labour and National Service); "Safety in plant maintenance", C. A. Beaton (Monsanto Chemicals); "Safe transportation and storage of chemicals" (Works Safety Committee of Association of British Chemical Manufacturers). A Brains Trust will also be included.

Programme and forms of application are available from Association of British Chemical Manufacturers (Intelligence Officer), 166 Piccadilly, London, W.1.

★ ★ ★

U.K. CRUDE

On February 23 the 700,000th ton of crude oil was produced from A.I.O.C.'s English oilfields at Eakring, Nottinghamshire, and Formby, Lancs. Annual production from these fields, which started production in 1938, is in the region of 50,000 tons.

Drilling began at the end of February on a new well near Ainsdale-on-Sea, Southport, Lancs. where last December the drilling of a test well stopped at about 4300 ft.

★ ★ ★

LONDON BRANCH SUPPER

On April 22 the London Branch of the Institute is holding its annual Fork Supper at Manson House. Each person will be served an adequate meal between 7.30 and 8.30 p.m., a film show will run continuously from 8.30 until 10.15 p.m., and there will be a licensed bar. Tickets, 6s. 0d. each, are obtainable from Committee Members.

FORTHCOMING MEETINGS

THE INSTITUTE

Annual General Meeting followed by **Presidential Address,** by C. A. P. Southwell, M.C., B.Sc., on **Kuwait.** At Institution of Mechanical Engineers, Storey's Gate, London, S.W.1., A.G.M. 5 p.m. Address, 6 p.m., April 24.

The Distribution of the World's Oil Reserves. G. M. Lees, M.C., D.F.C., Ph.D., F.R.S. At 26 Portland Place, London, W.1, 5.30 p.m. (*tea 5 p.m.*), May 14.

IP Week-End Summer Meeting. At Hastings, June 27-29.

London Branch

The Branch will Debate. At 26, Portland Place, London, W.1, 6 p.m. (*tea* 5.30 *p.m.*), May 21.

Visit to Esso Refinery, Fawley, June 21.

APPOINTMENTS VACANT

ESSO Petroleum Company Limited, Refinery Department, Fawley, Southampton, have the following staff vacancies:

A. *Assistant Technical Superintendent:* Assistant Superintendent required in the Technical Department. Duties will cover the direction and co-ordination of the work of the various Sections of this Department, including Planning of Refining Operations, Process Engineering and Laboratory functions. Candidates should have preferably a good degree in Chemical Engineering and some years' experience in the petroleum refining industry in a responsible technical capacity. The post calls for qualities of initiative, alertness and leadership.

B. *Process Engineering Supervisor:* required in the Technical Department to plan and co-ordinate the work of the various sections of this Department dealing with the problems of operation, design or modification of refining plant. Candidates should have a good degree, preferably in Chemical Engineering, with some years' experience of work carried out at a supervisory level in the petroleum or related industries and have a sound knowledge of refining operations.

C. *Distillation Section Head:* required in the Technical Department, to supervise the work of a group of up to six graduates, covering the operating problems relating to crude running, and plant modification or design in the same field. Candidates should have a good degree, preferably in Chemical Engineering, and experience in petroleum distillation or allied industries.

The above senior posts carry four figure salaries to the right men, appropriate to

their responsibilities. The Company has an excellent and comprehensive Pension Scheme. Recreational facilities of all descriptions are available, in a pleasant rural area bordering Southampton Water.

Applications should be sent in writing to Employee Relations Superintendent at above address, giving, in confidence, details of age, qualifications, experience, availability, present salary and salary required.

ESSO Petroleum Company Limited, Refinery Department, Fawley, Southampton, have the following staff vacancies:

Mechanical Engineers: required in Mechanical Department for work of a practical nature involving the organization and planning of all maintenance and construction work in a section of the Refinery. Candidates should have a University degree and some relevant experience in the Petroleum or related industry is essential.

Mechanical Engineer: required in Technical Department for work in connexion with operating problems on compressors and pumps as used in the Petroleum Industry. Experience in this field desirable, but not essential. Candidates should have a good honours degree in Mechanical Engineering.

Engineering Stores Asst. Supervisor: Candidates should have practical experience of engineering work and materials used in Refinery or similar process plant, with good organizing ability and be capable of co-ordinating and planning for maintenance requirements, providing for alternative materials if necessary. They should have a University degree (not necessarily in Mechanical Engineering).

Chemical Engineers and Chemists: There are several vacancies in the Technical Department with good prospects for Chemical Engineers and Chemists. Candidates should have good honours degrees, and experience in the Petroleum or allied industries would be an advantage.

All the above are regular posts, with salaries appropriate to age, qualifications and experience. There is an excellent and comprehensive Pensions Scheme; recreational facilities of all descriptions are available in a pleasant rural area bordering Southampton Water.

Applications should be sent in writing to Employee Relations Superintendent at above address, giving, in confidence, details of age, qualifications, experience, availability, present salary, and salary required.

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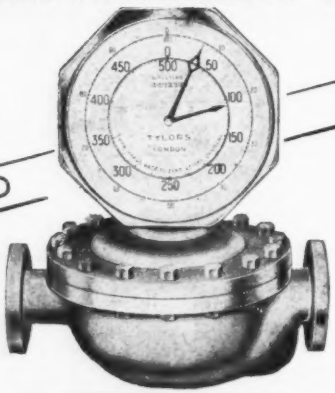

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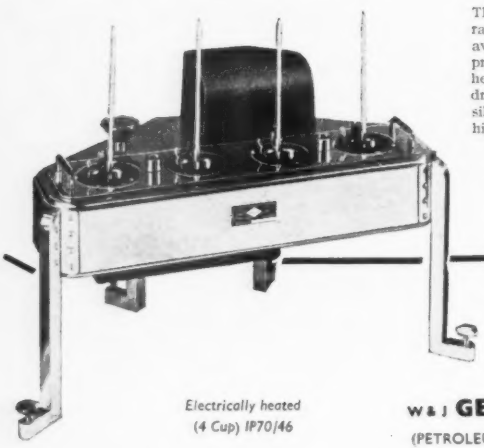

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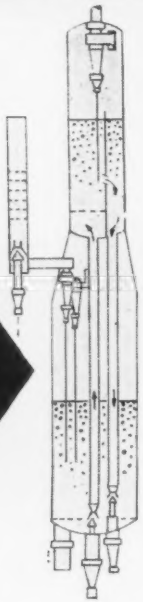

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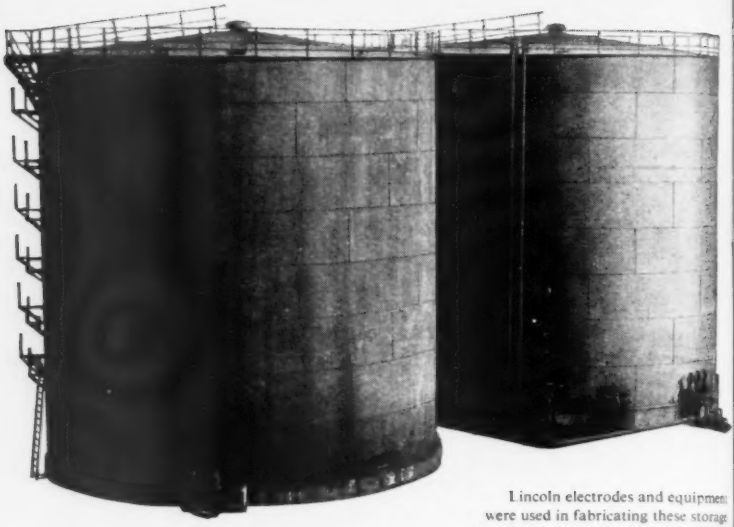

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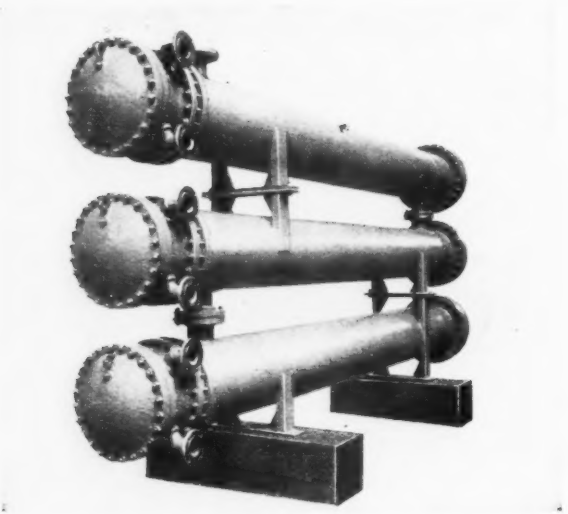

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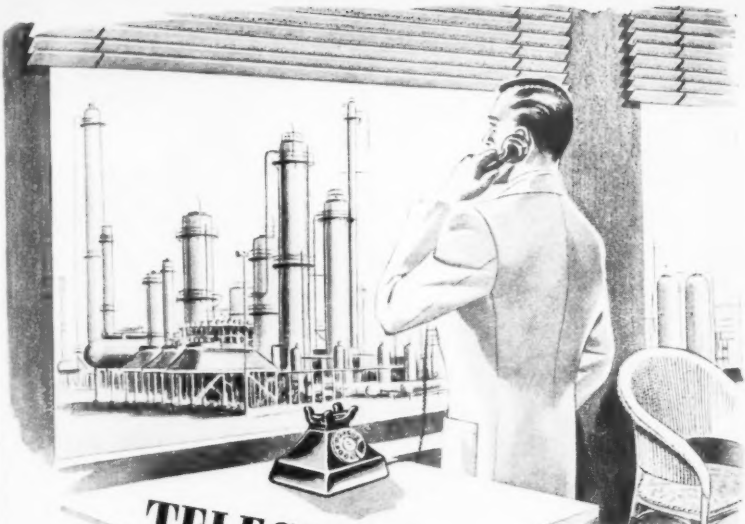

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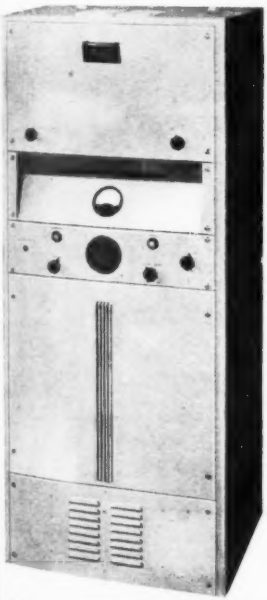

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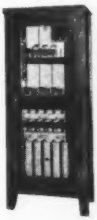

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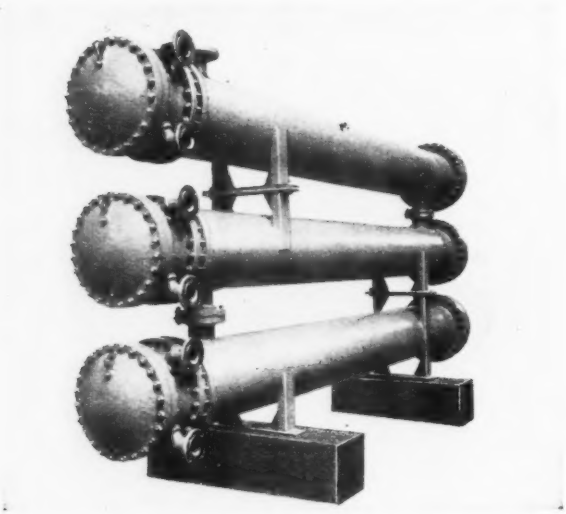

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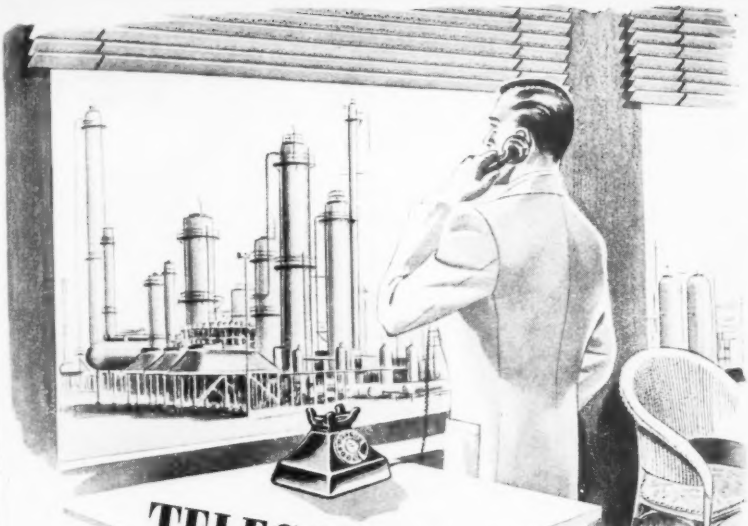

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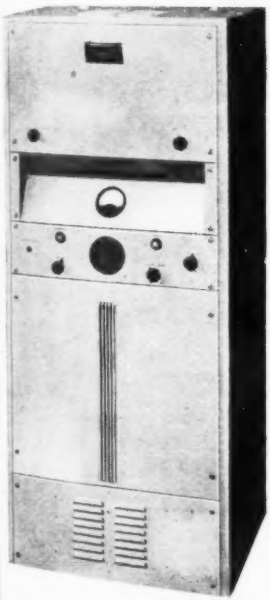

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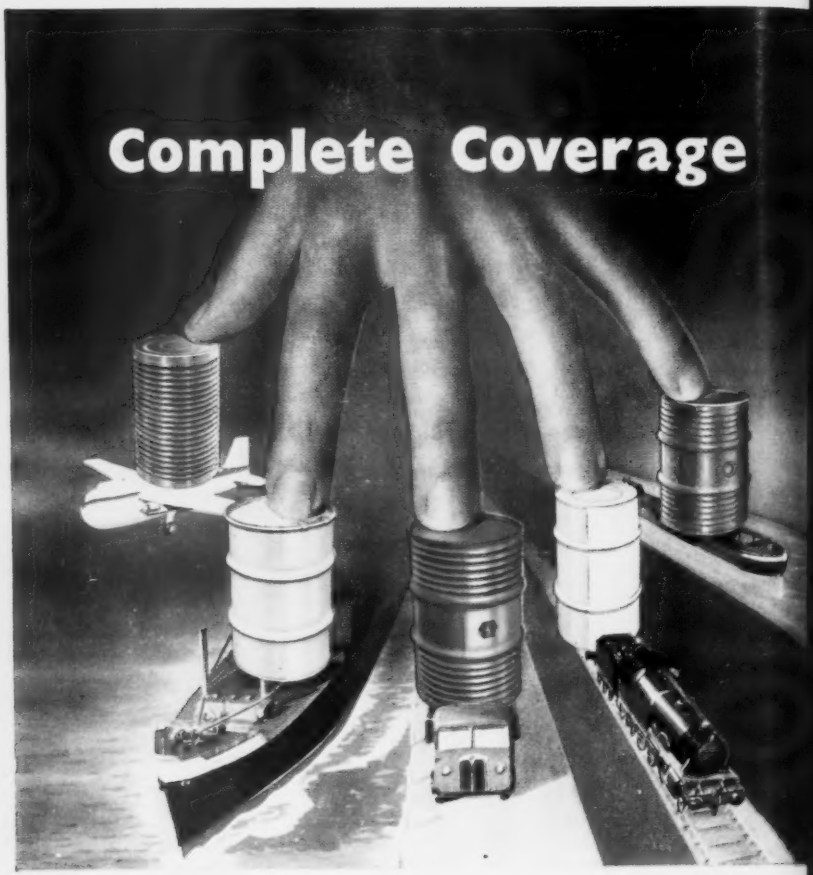

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